POWER PLANT ENGINEERING

Established Over 30 Years

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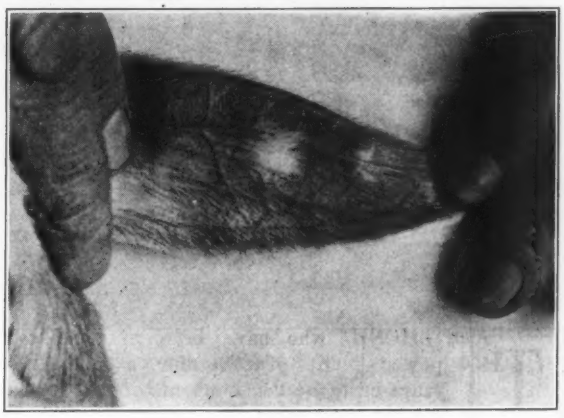


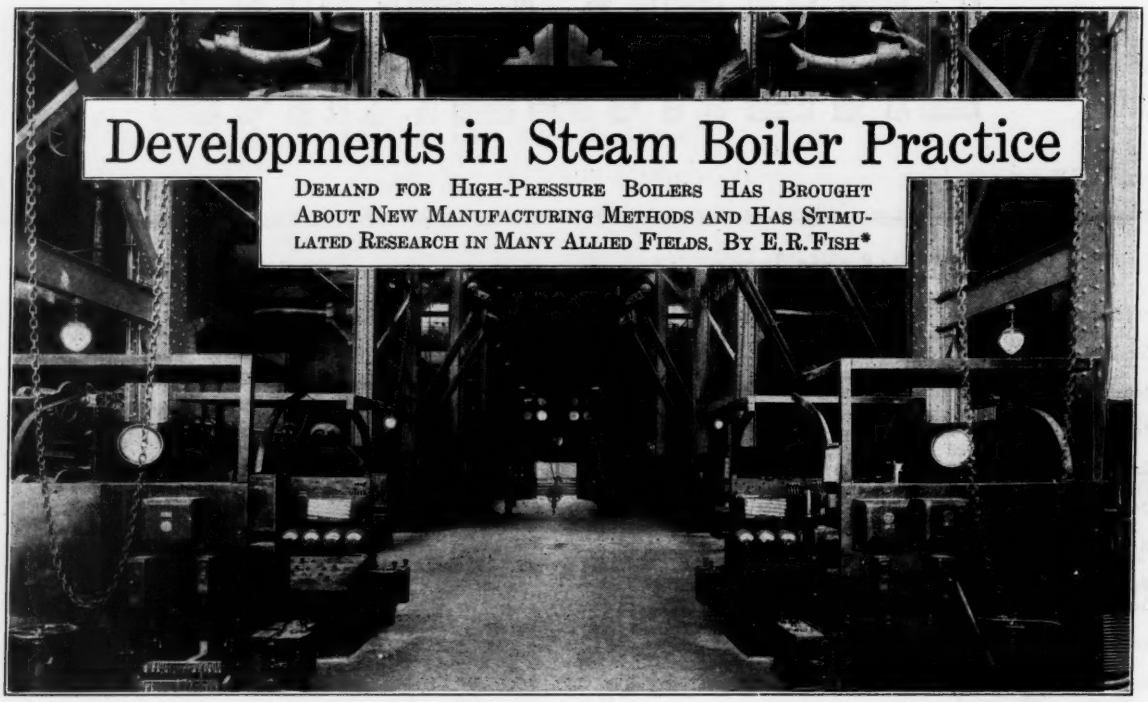
How Bunny's Hair Turned White

JUST LOOK at this poor rabbit—it's having its little ear pulled. Poor bunny, his is a sad lot. For no reason at all he is having his ear pulled by those cruel fingers at the sides of the picture. Whose fingers are they? Well, to tell the truth, we don't know, but they might be those of Dr. W. D. Coolidge, the world-famous scientist of the General Electric Co. research laboratory—the inventor of the modern X-ray tube.

No, Dr. Coolidge is not a cruel man who delights in pulling little bunnies' ears. Indeed no, he is the kindest of men but he has just invented the new cathode ray tube and to find out more about it, he exposed bunny's ear to the action of the cathode ray for an instant. And this is what happened: First, the hair on the ear disappeared and then, after the scab which formed fell away, another growth of hair appeared, but this time, instead of the original grey hair, it was a profuse growth of long, snow white hair.

This ray, which is in reality a stream of infinitely minute particles of electricity or matter moving at the inconceivable speed of 150,000 miles per second, is capable of producing many other strange effects. We have an idea that if you parked yourself in front of the cathode tube for a couple of minutes when it was operating, you would not be of much use in this world afterwards. You might have the unique honor of being a martyr to science, but who wants to be a martyr? There is no fun in that.

Anyway, they are playing with this tube at Schenectady and if you want to know more about it, turn to page 1349.



Developments in Steam Boiler Practice

DEMAND FOR HIGH-PRESSURE BOILERS HAS BROUGHT ABOUT NEW MANUFACTURING METHODS AND HAS STIMULATED RESEARCH IN MANY ALLIED FIELDS. BY E.R.FISH*

TO THOSE who have been in touch with power plant practice for a number of years past, the developments of recent years are but little short of astounding. This can be ascribed almost entirely to the marvelous growth of one piece of apparatus—the steam turbine.

Demands of turbine builders for higher and higher pressures and temperatures have reacted on boiler manufacturers to the extent of rendering much of the old boiler-making equipment obsolete and unusable. Many shops have been very largely re-equipped with tools adapted to the working of extremely large and heavy plates, and of which the handling apparatus alone is an important part. Even the capacity of the steel mills to meet the demand for large plates has been reached and the ability of the railroads to handle the bulky boiler parts offered for transportation has been greatly taxed. The last two years have witnessed a continuation of the growth of past years in size of units and of working pressures.

Three hundred pounds per square inch and above are now by rather general agreement regarded as high pressures, as are steam temperatures of 600 deg. F. and up. Even a couple of years ago pressures and temperatures less than these would have been called high. What the economical upper limits are has not yet been definitely determined and about which there is still much difference of opinion. It seems probable, however, that pressures of more than 650 lb. will not be used to any great extent for some time to come and it is not likely that pressures much in excess of 450 lb. will be the general rule for the immediate future. The future maximum temperature will probably be about 750 deg. F. Working pressures of 350 lb. and temperatures of 700 deg. F. are now relatively common and are growing more so. The very high pressures of 1200 lb.—1400 lb. are only for large central stations, where the whole scheme of operation can be properly co-ordinated. It is exceedingly unlikely that pressures even approximating these will become common in industrial plants. However, while the general tendency is toward high pressures, there are still many instances where the more moderate pressures of from say 150 lb. to 200 lb. should properly be used and where reciprocating prime movers are to be preferred.

*Vice President, Heine Boiler Company, Inc.

HIGH PRESSURES AND TEMPERATURES BRING OTHER PROBLEMS

The high steam pressures and temperatures are giving rise to other manufacturing problems. Old boiler-making practices are giving way more and more to machine shop operations, the better and more accurate workmanship being required for tightness rather than just for safety. The old materials, as excellent as they have been, have not the physical characteristics to give the strength without undue thicknesses. Metallurgists are now at work on the development of alloy steels that will combine the needed toughness and ductility with high tensile strength in the presence of high temperatures.

Practice of requiring high rates of evaporation continues unabated. Old boilers in many instances have been provided with fuel-burning apparatus that will supply heat in quantities sufficient to multiply the original rated capacities two, three or even four times. The economical limits vary with the conditions of each individual plant. Few, if any, boiler operators are now content to run at the old-time ratings. The result has been that the demand for additional steam has often been met by increasing the fuel-burning capacity rather than by installing more boilers. Or in the case of new boilers, smaller sizes are selected.

Increasing cost of fuel has directed attention to the

finer points of economical operation. By maintaining boiler settings in first-class condition and by providing indicating, measuring and recording instruments by means of which a full knowledge of the characteristics of all the factors involved is at all times available, the highest possible efficiencies may be attained and made continuous. A great variety of instruments have within the past very few years been designed for this purpose and they are being more nearly perfected day by day. Of these, the control systems that automatically co-ordinate the furnace conditions with steam requirements are perhaps the most important and many are marvels of ingenuity and practical utility. It should be always borne in mind, however, that any device embodying moving parts must have adequate attention and be given proper care if they are to continue to function dependably.

Methods of Using High Pressures Still in Course of Development

Several different methods of using high-pressure steam are in course of development. There is as yet no general agreement as to what is the best way. Data is accumulating all too slowly. Everyone who tries new methods and gets additional information should promptly contribute to the general knowledge. Only in this way can proper methods be developed.

Large central stations are usually the pioneers in new ways of generating and using steam. Being non-competitive, they most freely interchange information and give it wide publicity as well. To their initiative may be credited the great strides being made in the power plant field and to them the engineers more particularly concerned with the industries owe much.

Whether it is cheaper for an industry to use central station power or generate its own current is a question as yet unanswerable. Nor can it ever be generally answered either affirmatively or negatively. There are innumerable ramifications that require full and careful

FIG. 2. DEMAND FOR HIGH-PRESSURE BOILERS STIMULATES DEVELOPMENTS IN OTHER LINES. THIS SHOWS THE TESTING EQUIPMENT IN TESTING SAFETY VALVES FOR HIGH-PRESSURE BOILERS

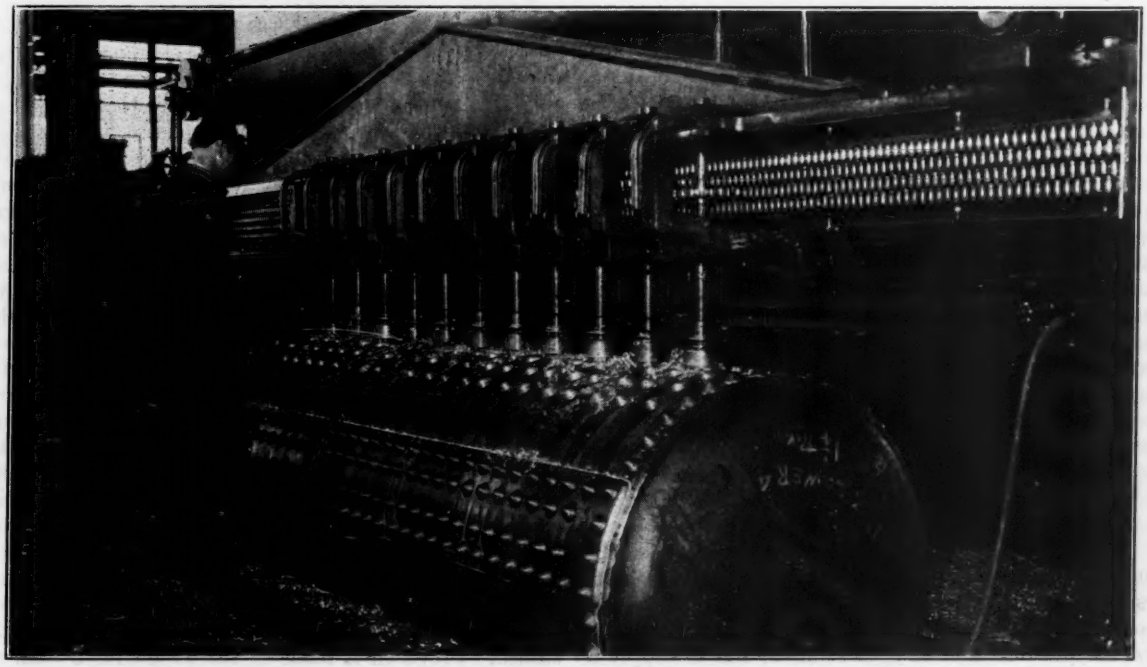


FIG. 1. HILL MULTIPLE DRILL USED TO DRILL TUBE OPENINGS IN THE DRUM OF A MODERN HIGH-PRESSURE BOILER. IN THE BACKGROUND AT THE LEFT MAY BE SEEN A 30-FT. PLANER USED IN PLANING THE EDGES OF PLATES

consideration in each individual case and only with a full knowledge of all the contributing factors can the proper solution be reached. In many instances an industry is justified from all points of view in making its own power, especially those of any considerable size or where process steam in quantity must be supplied. In many other instances the reverse is true. The representations of the central station solicitor should be taken as the presentation of only one side. A complete analysis of both sides is the only proper method of determining the answer. A considerable number of discussions of this phase of the use of steam have recently been published and should be carefully studied by one confronted with a situation of this sort.

Calculations involving the properties of high pressures and temperatures have until very recently been embarrassed by lack of authentic data. For several years a highly technical series of experiments have been in progress at the Massachusetts Institute of Technology

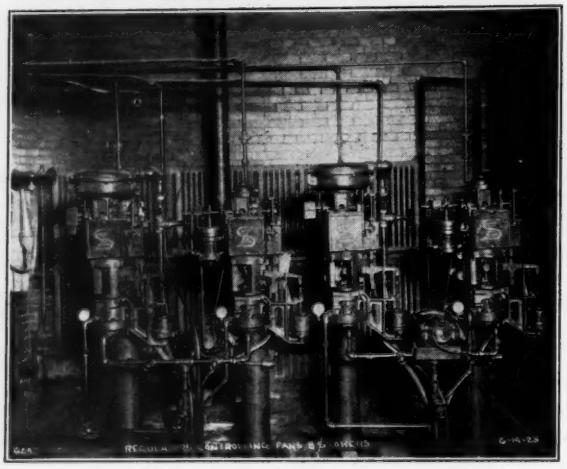


FIG. 3. AUTOMATIC REGULATORS FOR CONTROLLING FANS AND STOKERS INSTALLED IN A LARGE CENTRAL STATION

sponsored by the American Society of Mechanical Engineers. These have now been carried to the point where the results are available and may be obtained in pamphlet form at the headquarters of the society.

Of but little less importance than the boiler is the superheater, now almost universally used. The demand for high temperatures coupled with tremendous volumes has created problems in location and size that involve real designing ability. Where to place the superheating surface in relation to the boiler heating surface is dependent on the boiler design and temperature desired. The radiant heat type has been largely used in the past few years with some considerable success but the convection type is still more generally preferred.

Water and Air-Cooled Furnaces an Important Development

Other items of heat-absorbing devices immediately connected with the boilers are economizers, air preheaters and water-cooled walls and arches. Of these the economizer is the oldest, but the desire to save the greatest possible number of heat units, and to supply a form of construction capable of withstanding modern pressures and of resisting the deterioration due to both internal and external corrosion has been the stimulus for recent improvements of this part of a steam-generating unit. Air preheaters are as yet relatively infrequently used. Their proper and profitable field is becoming better understood from those installations already in use, and they will doubtless be more generally adopted as the knowledge of their field extends. Water-cooled walls are primarily for the purpose of reducing the maintenance cost of the setting. They also serve as very efficient additions to the steam-making surfaces of the boiler. The past two years has seen a great increase in their use and of which there are a variety of arrangements. Even a basis of approximating the proper extent of cooling surface to accord with the operating conditions has been very recently proposed.

Manufacturers of fuel-burning apparatus and systems must be given credit for providing means and suggesting furnace designs for the combustion of immense quantities of fuel which supply the heat necessary to operate boilers at the very high rates of evaporation now so common.

Substantial improvements in the several types of stokers have recently been made contributing to high rates of combustion with minimum quantities of excess air. But the most outstanding progress in the last year or two has been made in the types of unit systems of pulverized coal, which make the use of fuel in this form possible in plants of moderate size.

Never before has the cost of operating a boiler plant economically and satisfactorily more fully justified the employment of perfected apparatus and the employment of competent operators. Continued developments and improvements in new methods and machines may confidently be anticipated.

Colfax Extension Progresses Rapidly

SINCE THE GROUND was first broken for the Colfax power plant of the Duquesne Light Co. in 1919, an almost continuous construction program has been carried on until at present the installed capacity has reached 190,000 kw. or approximately 253,000 hp., one-half of the ultimate development. At present construction work is being carried on for additional equipment, which will have a capacity of 80,000 kw. and is expected to be placed in operation during the summer of 1927.

The first two units of the plant are identical, with the exception of some minor details in some of the auxiliary equipment. They consist of 60,000-kw. compound units having one high and two low-pressure elements, each driving a 20,000-kw. generator. The third unit consists of two 35,000-kw., single-cylinder turbines connected to a common bank of transformers. The fourth unit, for which preliminary work is now being carried on, will be similar in design to the third unit, except that it will consist of two single-cylinder machines of 40,000-kw. rating each.

Fourteen stoker-fired boilers were provided to furnish steam for the first two generating units, while for the next unit five pulverized coal-fired boilers were installed. Provision is made in the design for a total of eight pulverized coal boilers to take care of the additional capacity and three other boilers in this group will be added to accompany the new turbines.

Tendencies in Steam Boiler Furnaces

Combustion Rates of 40,000 to 50,000 B.t.u. Per Cubic Foot of Furnace Volume Are Predicted for Progressive Installations. By E. G. Bailey*

FINDING a suitable refractory for combating our modern furnace problems is a question which seems almost hopeless. While certain high grade refractories may have an appreciably longer life than the best clay brick, there is no such thing as an impregnable refractory when it is subject to temperatures as high, or higher, than the fusing temperature of the ash, which is omnipresent in all furnaces and coats every square inch of the walls. As soon as this ash is heated above this melting temperature, it fluxes with the bricks and runs down the wall carrying some refractory with it. High grades of refractories go more slowly, but they are not sufficiently resistant to make them last over a period of years. The increased cost of such refractories often makes the economic balance a matter of question. It seems then that the only way to hold a refractory wall is to keep its surface cooler than the melting point of the ash. In other words, a reduction in temperature

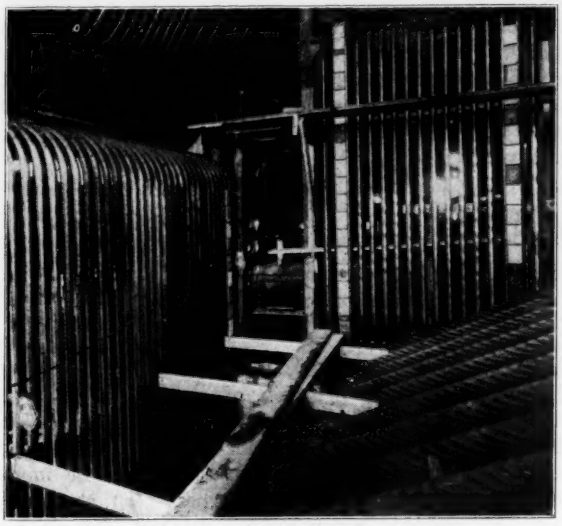


FIG. 1. WATER-COOLED SIDE AND BRIDGE WALLS FOR UNDERFEED STOKER FURNACE UNDER CONSTRUCTION

alone is the only effective means of retarding the erosion and destructive action of the ash from our usual run of coal.

Fusing Temperature of Ash Complicates Refractory Problem

Some plants are fortunate enough to be supplied with coal having an ash fusing temperature of 2700 to 2800 deg. F. The destructive action on furnace walls when burning this fuel is very slow indeed and the need for water cooling at these plants is not so pronounced. But many plants must burn coal having an ash fusing temperature of around 2200 deg. and some of them as low as 1900 deg. F. Under such conditions the maintenance of refractory walls and arches is a grave problem and some form of water cooling must be resorted to.

Power boilers of early design were internally fired with complete water cooling, such as the Scotch Marine, Locomotive Type, Lancashire boilers, etc.; why is it, then, that we have continued to put up with the refractory problem in our furnace design? Simply because we learned that best combustion efficiency was obtained by having furnaces of fairly sizable volumes with hot furnace walls. We have, therefore, preferred to obtain best combustion and good efficiency from hot furnaces even though we had to contend with the refractory problem. Now, however, we see an opportunity of tempering the wall temperatures by the application of water cooling so that the entire surface of the furnace can be maintained at any desired temperature.

FIG. 2. WATER-COOLED FURNACE WALLS WITH REFRACTORY IN PLACE

Modern Conditions Require Furnace Wall Protection

With such wall protection, the problem of burning coal takes on a new aspect. The large furnaces, where the walls were kept away from the impinging flame, gave rates of combustion as low as 10,000 to 15,000 B.t.u. per cu. ft. This meant very large furnaces for a given horsepower and it was somewhat of a misconception that these were needed in order to get complete combustion, while the greater need was for the minimizing of wall erosion. It was considered that a long flame was necessary to burn pulverized coal. This, of course, was true when burners were of such type as to produce long flame. The present tendency, however, is toward turbulence, mixing the fuel and air as they enter the furnace, producing a very short flame.

Economical burning of pulverized coal calls for smaller water-cooled furnaces, turbulent burners and finely-pulverized coal. It is quite all right to offset reduction in furnace volume with turbulence but in order to minimize refractory troubles with smaller furnace volumes there is a tendency for many types of furnace

*President of the Fuller-Lehigh Co.

construction to have considerable exposed water-cooling surface, thereby lowering the temperature of the furnace. Many of the direct-fired unit systems are producing rather coarse coal.

All three of these factors, namely, coarse coal, cooler furnace and smaller volume, tend to give slow and incomplete combustion. Turbulence aids combustion but turbulence alone cannot offset material changes in all of the other three factors at the same time.

In my opinion, the proper procedure is to reduce furnace volume to a reasonable amount, maintain as high a furnace temperature as the fusing point of the ash will permit, obtain fine pulverization and burn with as much turbulence as possible.

Adherence of clinkers to side walls of stoker furnaces where they interfere with the free motion of the fuel and the removal of ash has been troublesome with underfeed stokers, but designs have been worked out whereby properly cooled zones in the fuel box entirely prevent the adherence of such ash. Cooling action in other parts of the furnace holds the walls below the slagging point and greatly increases the life of the furnace, yet maintains the maximum temperature consistent with the elimination of slagging.

Chain grate stokers are particularly sensitive to the proper construction of arches. The purpose of an arch is to radiate heat to that portion of the fuel bed where ignition must take place. It is, therefore, obvious that an arch must be hot, yet the deterioration through spalling and the fluxing by low fusing temperature ash, wastes arches away until their maintenance is a matter of serious importance. The arch in the future will be a refractory-faced, water-cooled structure, maintaining as high a temperature as the fusing temperature of the ash will permit.

Water Screen Aids Ash Removal

Removal of ash from pulverized coal fired furnaces is not always an easy matter. The prevalent use of water screens or water cooling in the lower part of the furnace has accomplished a great deal in this direction. As higher ratings in smaller furnaces are obtained, however, the problem becomes more difficult. Where rates of combustion approach 30,000 B.t.u. per cu. ft. it is difficult to keep the lower part of the furnace 1000 or 1200 deg. cooler than the main part of the furnace where high temperatures are required for good combustion efficiency.

In some cases ash is being tapped off in a molten condition like slag from a blast furnace with satisfactory results. It is quite likely that this practice will be more generally adopted, especially with coals having low fusing temperature.

While the average pulverized coal furnace today is operating at less than 15,000 B.t.u. per cu. ft., it is predicted that within the next few years this will be doubled and the more progressive installations will be operating up to 40,000 or 50,000 B.t.u. per cu. ft. of furnace volume.

Recent Developments in Air Heaters

Careful Analysis of Each Plant Must Be Made in Deciding on Use of Air Heaters, Economizers or Combinations of the Two. Discussion of Construction and Operating Details. By G. C. Derry*

COMMERCIAL USE of air heaters dates from the early part of the nineteenth century. The available information indicates that they were originally adopted as a means of smoke elimination rather than for economic reasons. Their value as a heat-saving device was recognized, however, and they were applied extensively to marine boilers. In this work the well-known tubular type played the most important part and to date there are installations of this kind serving more than 30,000,000 hp. In spite of this fact there seemed to be an inexplicable lack of published information covering their performance and probable life. During the period from 1916 to the present time, the soaring prices of coal caused designing engineers to seek anything that would save heat. Interest in air heaters in the United States dates from this recent period and, judging from the number of inquiries, it is still active. Spot market prices of coal, f.o.b. the mine, are about 165 per cent of the 1913 level, and will probably remain there while we continue exporting to England and some of England's former customers. This price condition, added to present freight rates and handling charges, is holding the delivered cost up to the point where it is economically important to save every last B.t.u. consistent with reliable operation.

All the types of air heaters which have appeared on the market have employed, as a means of transmitting the heat, either the principle of convection or of regeneration. The latter is really a form of convection, therefore the classification of air heaters automatically passes on to the details of construction. One might easily separate them into two types: (a) stationary and (b) movable regenerative, although this is not strictly true, since there are forms of air heaters which come within both of these subdivisions. In the stationary class can be included the plate type, plain and corrugated, removable and reversible; and the tubular type fixed and removable. Of the movable regenerative type the Ljungstrom air heater, which is made of corrugated plates, is more widely known, although numerous patents have been issued covering this type using plates, plain and corrugated.

Air Heaters Are Applied Mostly in Heating Combustion Air

Air heaters in this country have had their greatest application in power stations. They are also used to heat buildings and in certain heating and drying processes. Their application in the last-mentioned fields is not extensive at present, if this company's experience can be taken as an index. Fully 98 per cent of our work on this type of apparatus has dealt with the application of air heaters to absorb heat from the escaping gases and return it to the furnace in the form of

*Manager, Fuel Economizer and Mechanical Draft Dept., B. F. Sturtevant Co., Inc.

heated air. We are giving little thought at present to the use of this type of air heaters in heating buildings and process work, since the engineering world with which we come in contact seems also to be giving it little attention. One interesting form of air heater applied to process work is the Briner economizer. This consists of corrugated plates and is used mainly in paper mills to absorb the heat in steam rising from the machine rooms. Formerly this steam was free to condense on any cool surface and became annoying as well as destructive. Now this simple interchanger not only disposes of the steam but returns the resulting hot air with its vapor-absorbing quality to the upper parts of the machine room.

So far, our experience leads us to believe that in most industries it is more economical to recover the stack loss by means of air heaters or economizers and to apply this recovered heat towards increasing the efficiency of the boiler room rather than to attempt to use it in the plant itself. It is often found that there is insufficient waste heat available in the flue gases to supply the required amount of heat to the process.

There are at least two fundamental reasons why air heaters are being adopted in central stations. First, and most important, is the direct saving in sensible heat which is returned to the furnace; second, is the possible improvement in combustion and reduction of ash pit loss when using low-grade fuels. Zoning or stratification, with its resultant smoke and CO loss, will occur with powdered fuel, especially if the gases strike a water wall or other relatively cold surface. With heated air, ignition is accomplished much quicker, the furnace temperature is raised and the effects of zoning largely eliminated. A third consideration in favor of air heaters is the effect upon flame length when applied with powdered fuel. This effect points toward a possible reduction in furnace volume necessary, which would mean lower installation costs, but the extent of this effect has not yet been expressed in definite terms.

Comparison of Air Heaters and Economizers

Our experience in investigating the feasibility and amount of surface to be used has been decidedly interesting. Assuming a given set of operating conditions, we have found that to produce approximately the same recovery (final gas temperature), draft loss, and so on, an air heater will contain at least twice as much heating surface as an extended surface economizer. In spite of this fact, present competitive conditions have placed the price of air heater surface where, considering only the bare apparatus in each case, the air heater shows a greater return on the investment than the economizer. However, when the complete installations are compared, charging against each a just proportion of the cost of the fans and the power to drive them, ducts, insulation and other operating expenses, it becomes doubtful if an air heater would be a better proposition than an economizer.

This happens without going further into the problem and considering the indeterminate life of the air heater as against that of the economizer, which experience shows is at least as long as that of the boiler which it serves. Even with the limited experience with air heaters in this country, there are some which we know have become useless from corrosion in two or three years, while others are giving promise of life nearly equal to that of their competitors—the economizers. For safety from corrosion the final gas temperature should not be dropped below 250 deg. F., which is close to the dewpoint of the sulphurous gases. A number of our studies have shown the economic limit of final gas temperature in the neighborhood of 300 deg. F. If, under these conditions, the complete study favors the air heater, then its installation would be justified. Should the economic conditions point to a final gas temperature lower than 300 deg. F. and especially below 250 deg. F., which is often the case, then the advisability of the air heater should be seriously questioned and special attention given to its physical properties. The questions should be asked: How long is it likely to last under the conditions? What provisions are made to care for deterioration? How easily can either partial or total replacements be made? If the air heater fails in service, how seriously will the station performance be

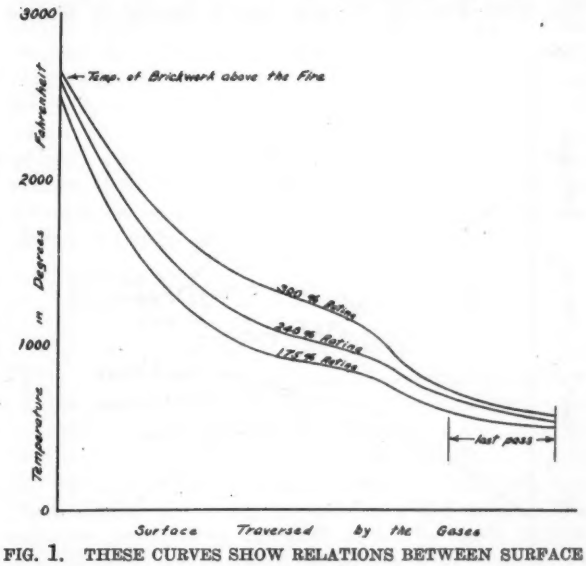


FIG. 1. THESE CURVES SHOW RELATIONS BETWEEN SURFACE TRAVERSED BY GASES AND FURNACE TEMPERATURES, EMPHASIZING THE COMPARATIVE INEFFECTIVENESS OF THE LAST PASS

affected, and how long is the air heater apt to be out of service?

With the low final gas temperatures obtained with an air heater, the available stack draft is reduced to the point where it cannot be depended upon to aid the fans. Also, when the heater is out of service for any length of time, moisture and soot will collect and cause corrosion over a localized area and even when again put into service, this corrosion will continue, since the sulphurous acid will not be driven off except under very high temperatures. Herein lies considerable food for thought over which operating engineers will be deeply concerned a few years hence.

Combination of air heaters and economizers is a special case, and requires careful investigation of the design of the entire station. If the feed water is to be amply heated by stage extraction, the remaining water temperature range through which the economizer may work is likely to be so small as to preclude its use. If the yearly coal bill is high enough to justify even

this saving, obviously the relative sizes of the economizer and air heater to be installed will be different from that which would be indicated for a station having an entirely different heat balance arrangement.

About six years ago the economizer business received a temporary setback when 20 high boilers came in style. Not a few engineers tried the experiment of buying a somewhat larger boiler than was necessary for the job, believing they were combining the boiler and economizer. Coupled with this was the improvement in station economy by the extraction cycle, which, when carried far enough, heated the feed water as high as an economizer would heat it. This cycle showed remarkable improvements in turbine performance on a B.t.u. per kw-hr. basis, but incidentally a respectable amount of heat was still going up the stack, even with the 20 high boiler.

The comparative ineffectiveness of the last pass of the boiler is well understood and is indicated in Fig. 1. The work done by the last pass is limited by simple

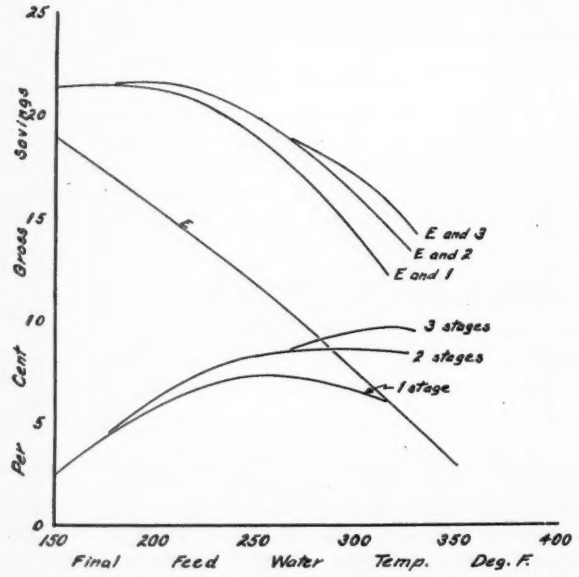


FIG. 2. LOWER GROUP OF CURVES SHOWS SAVINGS BY EXTRACTION FEED-WATER HEATING. UPPER GROUP REPRESENTS SAVING BY COMBINATION OF EXTRACTION HEATING AND ECONOMIZER

temperature considerations and it is obvious that some other form of heat-transmitting device is indicated, at the same time making possible a reduction in the size of the boiler. With the feed water temperature already so high as to exclude an economizer, the most natural way of disposing of the heat in the flue gas was to transmit it to the incoming air by means of an air heater. In this way most of the economizer manufacturers were literally forced into the air heater business, in order to keep pace with the state of the art. In addition there are certain installations that are better adapted for heated air. Fortunate is the manufacturer who builds both economizers and air heaters, so that an unprejudiced study can be made, especially if that manufacturer can supply the fans and their driving units in order to ensure that this part of the equipment is not taking an undue amount of power, thus reducing the savings which are shown by the study of the air heater alone.

Other Factors Must Be Considered

Not all of the improvement in heat economy accomplished by these various cycles is consistent with reliable operation, nor the production of the cheapest power. The station piping becomes more complicated and expensive, and the power output of the turbine generator is reduced for any given amount of steam supplied. Further, each such unit, together with its boilers and everything else, must of necessity be an installation by itself, since it is well nigh impossible to interconnect two such installations to a common feed-water system which would serve the entire station. Under certain conditions this may be done, but the dividing line is crossed when the temperature of extraction requires water under feed pump pressure.

The curves in Fig. 2 may now be of interest. The lower group represents the savings effected by one, two, and three-stage extraction. The particular station on which these data are based has an operating pressure of 275 lb. per sq. in. gage and a corresponding temperature of saturation of about 414 deg. F. It was assumed, for purposes of safety, that the final temperature of the water leaving the economizer should be limited to 380 deg. F. and any point on the curve marked E represents the saving possible of attainment with an economizer heating the feed water from the temperature due to extraction (the abscissa of the point) up to 380 deg. F. The summation of the lower set of curves and the curve E gives the upper set, marked "E and 1" and so on. The maximum is plainly around 200 deg. F. with two-stage extraction and an economizer to do the remainder of the feed heating up to the limit of 380 deg. F. This set of curves is admittedly not the economical answer to the problem (gross savings only are indicated), but it is fairly simple proof that when economy is the object an economized still has its place in the cycle.

Happily we are experiencing a return to these fundamentals, and finding a renewed interest being shown in this type of apparatus. Higher steam pressures have been responsible for the development of steel tube economizers. There were numerous objections to, and disadvantages of, the steel tube machine, but we feel that we have contributed a nice solution of the problem with our lead coated tubes. These are withstanding severe operating conditions imposed by both the gas and water and, with the extended surface now being used, make a compact arrangement very well adapted to unit installations.

Construction Details of a Plate Type Heater

The plate type air heater of our manufacture goes one step further into the problem by providing for the distribution of corrosion effects over both ends of the machine, instead of allowing it to become concentrated at one end. In addition, special corrosion resisting plates are used. Figure 3 shows the essential features of the chambers. The V-shaped clips are sprung over the front edges of adjacent chambers. To the sides of the chambers are welded step-cut strips arranged as shown, which in effect form a labyrinth seal for the gases passing along the outside of the chambers. Between the edges of adjacent chambers, and under the clips, is used a special form of cement, which is plastic under

such temperatures as are usually encountered. The chambers are pressed together by a simple jacking device. The clip is driven in place, closing the edges and thus forming a joint which is gas and air leak-proof. The clips also provide a smooth converging path for the air. To remove a chamber the clips are removed and the chamber is drawn in the opposite direction (to the rear). It will be at once evident that, due to the step-cut strips, only every other chamber is directly removable. This, however, is a minor consideration, since it is only necessary to withdraw a neighboring chamber very slightly to permit the removal of any chamber in the group, and is more than offset by the advantage of having a labyrinth seal.

We have also designed a tubular air heater with the added feature of lead-coated tubes, which have met with success in our economizers. Tubes have certain advantages in this kind of service. They are fairly cheap; when properly arranged they make a heater which is simple and inexpensive; and in case of failure they are

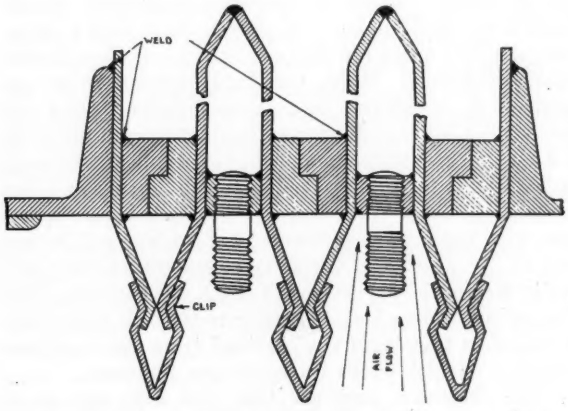


FIG. 3. ESSENTIAL FEATURES OF CHAMBERS OF A PLATE-TYPE AIR HEATER

readily replaced, especially if the heater uses a standard size and length.

Problems of Corrosion and Cleaning

It is with such ideas as these that we have designed our line of fuel saving equipment, to meet the demand that is being made upon this type of apparatus, and to meet it properly in all its phases. As we see it, there are two problems to be satisfactorily solved: first, the problem of corrosion, second, the problem of cleaning. We prefer to discuss these problems frankly at this time rather than to exploit air heaters in too optimistic a fashion. This might lead the customer to expect too much, and result in disappointment and lack of faith later. It may be that this apparatus will show such generous returns that one could well afford to replace chambers or tubes in three or four years, but our policy is to so design that we can get the maximum length of life with the construction outlined above.

The second problem varies with different installations. In some cases cleaning presents no difficulty whatsoever, and in others it has proven very troublesome. Some manufacturers have claimed that the weaving of the plates is sufficient to clean the machines, but practice has proved that more positive methods must be employed. It is obvious that soot blowers, as ordinarily applied, are not sufficient on account of the length of the plates and tubes. We believe that the solution is to clean with hand lances and a wire brush, and this system is perfectly satisfactory if given the same care as in the operation of the boiler.

We have not attempted to deceive ourselves by taking or expressing a too optimistic viewpoint of the future of air heaters. We believe time alone will determine whether they will be discarded as uneconomical or take their place permanently in the boiler room. There is no question of the need for either economizers or air heaters, or a combination of both, so we have carefully prepared our designs, having in mind that each station presents its own particular problem. We wish to be prepared to manufacture the apparatus which is best for the job, whether it be economizers, either cast iron or steel, or air heaters, either plate or tubular. The fan side of the problem is too often neglected, which frequently results in severe fan requirements. A large portion of the fan power is directly chargeable against the savings shown by the economizer or air heater. High pressures require high tip speeds, which set up stresses that can be met only by the use of alloy steel and expensive fan construction. This increases the first cost, to say nothing of the attention which must be given to the balance of the fan wheels, shafts, bearings, foundations and controls.

Recorders for Oxygen in Feed Water

TO TEST the effectiveness of deaeration, a new recorder for dissolved oxygen in feed water has been brought out by the Cambridge Instrument Co., Ltd., of London, Eng. A continuous water sample is passed through a scrubber to make contact with hydrogen gas, the hydrogen displacing the oxygen in the water. Two coils are arranged in the arms of a wheatstone bridge, one coil being surrounded with pure hydrogen, the other by exhaust gas from the scrubber. Difference in heat conductivity of the two gases affects the resistance of the coils, unbalancing the bridge in proportion to hydrogen used in the scrubber and the galvanometer across the bridge records the amount of this unbalancing, which is proportional to the oxygen in the water. The range is up to 1 cu. cm. of dissolved oxygen per liter of water and the circuit may be arranged to operate a graphic record, also to sound an alarm when excess oxygen is reached.

The commercial set includes an electrolytic hydrogen generator, water supply control to the scrubber, indicator, chart driven by clockwork and mechanism for recording the galvanometer reading by a dot each minute on the chart. The record runs for 25 hr. All mechanism, including a rheostat for regulating current to the wheatstone bridge from a 2-volt battery is enclosed in a steel case.

IT'S ONLY the victims of a "sharp" man that call him shrewd. He gets by for a while, but it isn't long before you see the red flag and hear the hoarse voice of the auctioneer in proof that being "sharp" is no way to do business.

Recent Influences on Boiler Water Treatment

NEW DEVELOPMENTS IN STEAM GENERATION MAKE THE FEED WATER TREATMENT PROBLEM MORE IMPORTANT THAN EVER. BY J. D. YODER*

OF THE MANY recent innovations in power plant design, those closest related to boiler feed water treatment have been the higher ratings and higher pressures at which it has been found economical to operate boilers. Water-cooled walls have been devised to protect the brick work from the high furnace temperature obtained with powdered fuel burners, which high temperatures make possible operating boilers at high ratings. The water-cooled walls are subjected to the intense radiant heat of the furnace and thereby not only protect the brick work but serve to generate a large amount of steam. The high temperature to which these tubes are subjected produces a rapid deposition of scale in the tubes unless the water is properly treated to prevent scale formation. The accumulation of only a small amount of scale in these tubes will cause them to burn

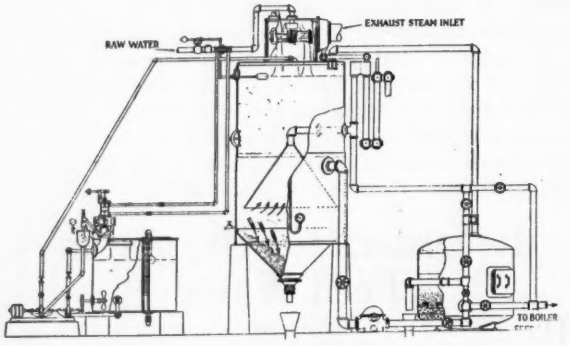


FIG. 1. DIAGRAM SHOWING DETAILS OF THE HOT PROCESS SOFTENER

out rapidly. To prevent burning the tubes by the intense radiant heat they must be clean so that the heat units will be rapidly absorbed by the water. Not only is it necessary to protect these tubes from scale but it is desirable to keep the total solids in the boiler as low as possible including both mud forming solids as carbonates of calcium and magnesium silica, iron oxide and alumina, and the soluble solids as the various sodium salts. Maintenance of low total solids is important to prevent priming at the desirable high rating of boiler operation.

Many of the high rating boilers equipped with powdered fuel burners and water-cooled walls are fed with distilled water from surface condensers with very little makeup, which later may also be distilled water from evaporators. Frequently, however, it is desirable to use jet condensers for various causes and in many industrial plants the exhaust steam may be used in process work or for various reasons cannot be returned to the boiler. This may make necessary feeding nearly 100 per cent makeup water to the boilers. These conditions place exacting requirements on the feed-water treating system. They demand a proper and dependable feed-water treatment.

The hot process water softener illustrated in Fig. 1 is now successfully treating feed water in a number of plants equipped with high rating boilers having water-cooled walls and burning powdered fuel. For some of these all the water fed to the boilers first passes through the water softener. The pressure on these boilers varies from 175 lb. to 350 lb. per sq. in. One of these plants for which this hot process softener has been purchased but not yet installed, proposes to carry 400 lb. per sq. in. boiler pressure.

Some of the boilers are of the steam generator type with fin tubes as manufactured by the Combustion Engineering Corp., others of the Babcock and Wilcox type with Bailey water-cooled walls.

Some of these softeners are furnished with deaerating heaters for driving off practically the last trace of oxygen; others are supplied with the standard design of Cochrane Heater. When the boilers are provided with steel tube economizers either integral with or independent of boilers, deaerating heaters are strongly recommended as small amounts of oxygen even with a chemically-treated water are likely to cause corrosion of steel tube economizers. Where steel tube economizers are not used, such deaerating as may be obtained from the standard Cochrane Heater as regularly furnished with the hot process softener coupled with chemical treatment is sufficient to protect boilers from corrosion. The heaters regularly furnished by the Cochrane Corporation with hot process softeners heat the water to within two to five degrees of the steam temperature, and generally reduce the oxygen to 0.2 or 0.5 ml. per liter. The deaerating heaters heat the water to the full steam temperature so that benefit is obtained from the high temperature as well as the better oxygen removal.

The chemicals used are lime and soda ash which many years of experience have demonstrated to be the most economical for feed-water treatment, and as a rule these chemicals reduce the total solids below what might be obtained from any other practical treatment, and therefore give a water less likely to cause priming of boilers.

THE USE OF TRI-SODIUM PHOSPHATE

The theory has been advanced by certain chemists that lime and soda ash are not suitable chemicals for treatment of waters for high pressure service, i. e. pressures exceeding 150 lb. per sq. in., the reasons advanced being the greater tendency for formation of calcium sulphate scale at the high temperatures corresponding to the pressures and the well-known fact that a considerable portion of the sodium carbonate in the boiler dissociates into sodium hydrate and carbon dioxide, the latter going off with the steam. For these reasons tri-sodium phosphate has been advocated for treatment of water for high pressure boilers instead of sodium carbonate.

The writer has not observed any difficulty in protecting boilers from calcium sulphate scale with a lime and soda ash treatment in a hot process softener with boiler pressures as high as 350 lb. per sq. in., although it is a recognized fact that tri-sodium phosphate may be used instead of soda ash to supplement soda ash with the hot process treatment, if actual experience demonstrates the

*Manager, Water Purification Dept., Cochrane Corporation.

tri-sodium phosphate to be better. It is observed that the chemists who have favored tri-sodium phosphate have had little or no practical experience with external treatment but have chiefly been engaged in treatment of the water within the boiler. For internal treatment tri-sodium phosphate instead of soda ash has for many years had its advocates but for the treatment of water for the modern high-pressure boiler plant the advisability of external treatment is now quite generally recognized.

One of the large public service plants having jet condensers has been successfully using the hot process treatment for a number of years although because of the unusually low sulphate content of the water the ratio of sodium sulphate to sodium carbonate has always been somewhat lower than recommended by the boiler manufacturers and Section VII of the American Society of Mechanical Engineers Boiler Construction Code, from the standpoint of preventing the possibility of caustic embrittlement. The boiler pressure at this plant is 280 lb. per sq. in. for which the A. S. M. E. Boiler Code calls for a ratio of sodium sulphate to sodium carbonate of not less than three to one.

The excess sodium carbonate required for protecting the boilers from scale was considerably less than one and one-half grains per gallon but with sodium sulphate in the treated water, less than a grain per gallon it was customarily less than the sodium carbonate instead of three times the sodium carbonate as the A. S. M. E. Boiler Code calls for.

The attempt was made to use tri-sodium phosphate instead of soda ash for treatment of this particular water, having in mind that the phosphate radical would not dissociate as the carbonate radical to form sodium hydrate, and believing that it might be practical to carry sufficient excess phosphate in the boiler to prevent the formation of scale and at the same time keep the sodium hydrate as low as required to satisfy the sulphate to carbonate ratio to prevent embrittlement. Experience, however, was quite unfavorable for even though sufficient tri-sodium phosphate was fed to the boiler to give a ratio of sodium hydrate considerably in excess of sodium sulphate, the boilers were not satisfactorily protected from troublesome deposits. These deposits might not have been strictly termed boiler scale but they were far more troublesome than the customer experienced when feeding soda ash with a consequence that the use of tri-sodium phosphate was discontinued and soda ash resumed. The explanation for the formation of caustic soda while feeding only tri-sodium phosphate probably is that the tri-sodium phosphate reacted with calcium carbonate to form calcium phosphate and sodium carbonate. The latter was hydrolized to caustic soda just as does the small excess of soda ash when it is used for treatment.

By using di-basic phosphate instead of tri-basic phosphate this alkalinity would probably have been somewhat lower but the results from the standpoint of protecting the boilers from deposits would have been no better. It therefore appears quite improbable from observations that the writer has made that tri-sodium phosphate will to an appreciable extent displace soda ash where water softeners are used. The cost of tri-sodium phosphate for the work accomplished is about four times as great as for soda ash, which represents a very practical objection and furthermore it does not appear quite so satisfactory for protecting the boilers as soda ash.

Maintaining Proper Sulphate-Carbonate Ratios

Aside from the effect that high boiler pressures and high ratings have had on the treatment of feed water in recent years probably the second most important influence on feed-water treatment has been the further crystallization of the opinions of chemists and engineers as to the advisability of maintaining certain ratios of sodium sulphate to sodium carbonate depending upon boiler pressures to insure protection of boilers from caustic embrittlement.

University of Illinois Bulletins 94 and 155, and Section VII of the A. S. M. E. Boiler Construction Code

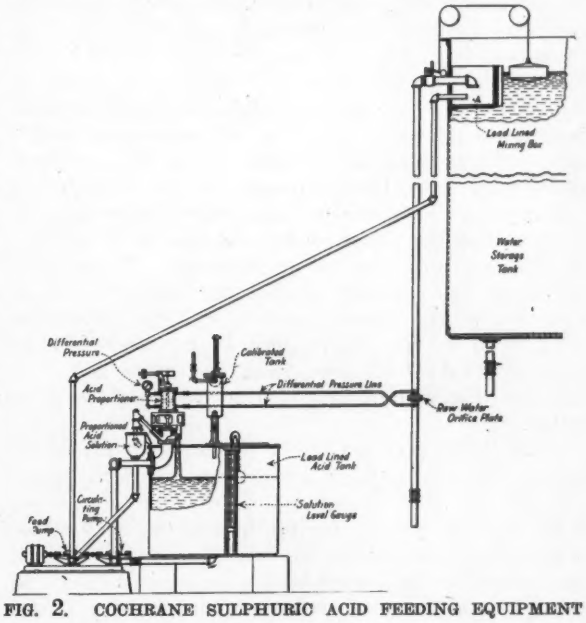


FIG. 2. COCHRANE SULPHURIC ACID FEEDING EQUIPMENT

probably had greater influence on this subject than any other recent publications, although it is to be kept in mind that neither publication regards the problem as finally solved. Further research and investigation is under way.

In the meantime evidence that has been submitted is sufficiently convincing that engineers generally give this relationship their consideration in selecting the proper equipment to install and the chemical treatment to be given. There are comparatively few plants where the sodium sulphate is so low that a proper treatment with lime and soda ash by the hot process method does not give a satisfactory relationship of sodium sulphate to sodium carbonate. For these exceptional plants probably the most practical way of providing a satisfactory relationship is by feeding a small amount of sodium sulphate with lime and soda ash which can very easily be done without installation of additional equipment.

If the relationship of sodium carbonate to sodium sulphate is naturally high and therefore undesirable from the standpoint of embrittlement which applies to certain natural artesian well-water supplies, or if a similar relationship of sodium carbonate to sodium sulphate is produced by the use of a Zeolite softener which

transposes calcium and magnesium carbonates to sodium carbonate, probably the best way to correct this unsatisfactory relationship is to feed sulphuric acid to the water to change some of the sodium carbonate to sodium sulphate.

Figure 2 illustrates the Cochrane sulphuric acid feeding equipment that has been furnished for this purpose.

Whereas the proportioning method used is essentially the same as is regularly used with the Cochrane hot process softener, feeding of the acid presents special problems particularly from the standpoint of proper selection of materials. A description of this feeding equipment may therefore be of interest.

The flow of raw water through an orifice in the piping which conducts the water to the storage tank creates a differential pressure which acts downwardly upon the piston. The downward force is balanced by an upward force maintained on the under side of a valve disk mounted on the piston rod. This valve disk is of the same area as the piston, so that the liquid pressure underneath the valve disk is at all times equal to the differential pressure on the piston and at the raw water orifice plate. The liquid pressure on the valve disk is maintained by a circulating pump which draws the acid solution from the bottom of the lead-lined acid tank and discharges to the chemical proportioner. The circulating pump has capacity to discharge against a higher head than will be imposed on the disk by the differential pressure on the raw water orifice, so that some chemical solution always discharges from this valve and falls into the solution tank in a continuous stream, as illustrated.

This liquid pressure forces acid solution through a small orifice, and as the effective pressures on the chemical orifice and on the raw water orifice are always the same, the acid solution passing through the small orifice is always proportional to the flow of water through the large orifice to the storage tank. The proportioned acid solution from the small orifice enters a receiving funnel and gravitates to the feed pump, which delivers it into a lead-lined mixing box in the top of the storage tank.

Concentrated sulphuric acid is purchased for this service in small quantities and in glass carboys. If required in large amounts, it can be furnished by the carload in steel tank cars and may be stored in steel plate storage tanks. Acid may be delivered from the storage tanks or from the carboys to the calibrated tank above the solution tank. This tank is calibrated in inches, so that the amount of acid fed at each charge to maintain the desired strength in the acid solution tank can easily be determined. The calibrated tank is of cast iron and contains a rubber float with rubber stem to indicate the level. Ordinarily steel piping with all-iron valves may be used for conveying the concentrated sulphuric acid solution.

Dilute sulphuric acid rapidly attacks iron for which reason acid-resisting metal must be used wherever dilute acid comes in contact with it. The solution tank is lead lined and has within it a rubber float to indicate the level on a gage. The piping used should either be hard rubber, lead or lead-lined iron piping. The circulating pump, the feed pump, portions of the chemical proportioner coming in contact with the acid and the receiving funnel are cast from Everdur metal.

Expect to Spend $20,000,000 for Carolina Power Project

POWER executives of the South, charged with the duty of providing for larger expansion of power facilities, in order to keep pace with the industrial growth of that section, which is going ahead in an unprecedented way, are taking every step necessary to add to these power facilities, according to information obtained at the Federal Power Commission in Washington. That is evidenced by the fact that the Savannah River Electric Co., a South Carolina corporation with headquarters at Greenwood, S. C., has made application to the Federal Power Commission for license to construct a 120,000-hp. hydro power dam on the Savannah River, 20 mi. above Augusta, Ga., estimated to cost $20,000,000. The plan contemplates building of power lines to Charleston, Aiken, Greenwood, Edgefield, and other cities and towns in the adjoining territory in South Carolina, also to Augusta and various towns on the Georgia side of the project. Connection will be made with the distribution system of the Georgia Power Co. as a part of the interconnected power lines of the South extending from Raleigh, N. C., to Muscle Shoals. Through interconnection, the territory to be served by this project in Georgia and South Carolina will be able, in emergencies, to draw on the power resources of the large storage dams in Georgia and in Alabama, the steam plants in Alabama and from the Government plants at Muscle Shoals.

According to information available in Washington, the consumption of electrical energy in five Southern states has doubled three times in the last 9 yr. Based on this fact and assuming that the present rate of growth will be maintained, the forecasts of the future power needs for that section of the country, available in Washington, are shown in the following tabulations:

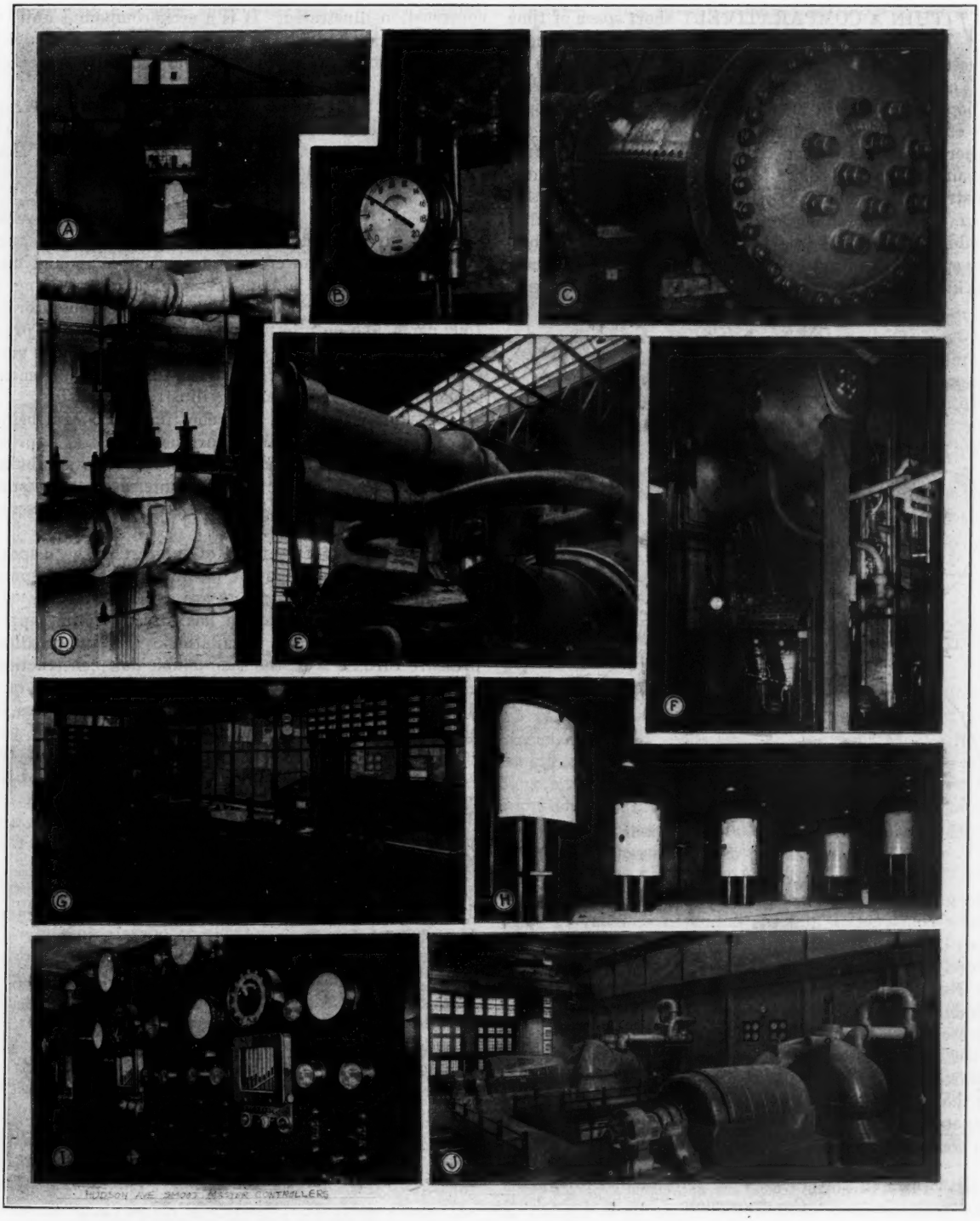
Year	Kilowatts Demand	Kilowatt-hours Consumption
1926	400,000	1,950,000,000
1927	480,000	2,300,000,000
1928	540,000	2,600,000,000
1929	620,000	3,000,000,000
1930	700,000	3,400,000,000
1935	1,000,000	5,000,000,000
1940	1,400,000	7,000,000,000

This estimate of future power needs considers the natural increase in population, the corresponding increase in manufacturing and the incoming of new industries as a result of the work of the operating companies through their industrial departments.

THE GOOD SAMARITAN HOSPITAL, Portland, Ore., has just finished installing two 300-hp. Heine water-tube boilers equipped with Chisholm full automatic burners. This is the first step in the remodeling of its power plant and it is planned to follow this by the installation of a generating unit, probably a uniflow engine set, together with an 8-t. York ice machine. G. M. Ely is chief engineer of the plant and is directing the work of remodeling.

WHEN HURRY interferes with safety, cut out the hurry, urges the National Safety Council.

Views of the Year's Power Developments

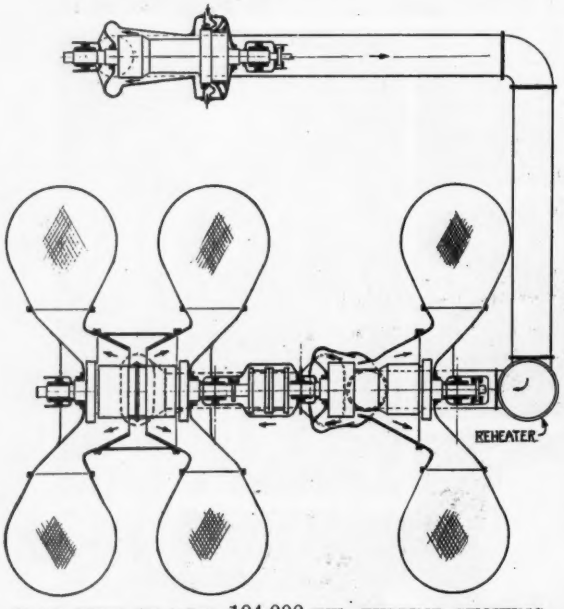


In these views, selected at random from many others, are shown a few of the developments in the power field during the past 18 months. At A, is shown a view of a modern coal-handling crane as installed at Columbia. B, shows a remote liquid level indicator for determining the water level in boilers. At C, is shown a high-pressure feed-water heater as installed at Richmond. D is a view of a motor-operated valve, many of which were installed during the year. Reheat piping for a large turbine may be seen at E. F is a view of a high-pressure boiler designed for testing safety valves. At G is a view in a modern control room. H is a view in the new high-voltage laboratory at Stanford University. A modern boiler control board is shown at I, while J shows a general view of the turbine room in one of the latest central stations.

Developments in Steam Turbine Practice

MANY INTERESTING NEW IDEAS IN TURBINE DESIGN ARE IN COURSE OF DEVELOPMENT. BY J. D. SCHMIDT*

WITHIN A COMPARATIVELY short space of time B.t.u. rates of turbine generator units have been almost halved. This great advance in the reduction of heat consumption per unit of electrical energy delivered, is popularly ascribed to improvement in turbine design. No one, however, is more ready than the turbine designer to admit that the reduction in power plant fuel consumption is due more to improvements in generator construction, condenser design, and boiler construction than to radical changes in the turbine art. Rather would he say, and it has been said, that the higher rotative speeds permitted by recent generator developments, the higher vacuum maintained by the latest condensers,



PLAN VIEW OF NEW 104,000-KW. TURBINE SHOWING ARRANGEMENT OF ELEMENTS

the greater steam pressures made possible by modern boiler construction and the improved economy of stage feed heating together with more efficient auxiliaries, are largely responsible for the overall results obtained.

Nevertheless, within the new limitations of design established by these contemporary developments, increases in capacity, reliability and efficiency together with improvements in methods of speed control and related matters, are being realized from day to day. It is the purpose of this article to describe briefly and in general terms, few of the items which have contributed in some degree to this advance.

LARGE CROSS AND TANDEM COMPOUND UNITS UNDER CONSTRUCTION

A year ago, the largest generator set in service was one of 62,500-kw. capacity. This has been eclipsed by a unit of 80,000-kw. recently placed in operation. This turbine has been described in the technical press and its construction illustrated. It is a cross-compound unit in two cylinders, of which the low pressure is of the double-flow type exhausting to a single surface condenser underneath.

There is being designed at this time, by the Westinghouse Electric and Manufacturing Co., a unit of 104,000-kw. capacity. Another manufacturer has contracted to build a set for a reported total capacity of 208,000 kw.

The 104,000-kw. unit mentioned embodies several novel features which merit some description. The turbine is a combination cross and tandem compound machine, consisting of a high-pressure turbine driving a 55,000-kw. generator and a 4000-kw. house generator at 1800 r.p.m. and an intermediate pressure and a low pressure turbine in tandem driving a 45,000-kw. main generator, likewise at 1800 r.p.m. The turbine arrangement is shown in the accompanying illustration.

The unit is designed for reheating, the steam being taken from the high-pressure turbine exhaust at approximately 41 lb. abs. and dry and saturated to a tubular reheater placed in front of the intermediate-pressure unit and passing thence to the intermediate-pressure inlet at 500 deg. F.

One of the chief features of interest is the disposition of the steam flow in the intermediate and low-pressure turbines. These turbines are arranged on the "divided-flow" principle, which has already found application in certain marine installations. The intermediate pressure turbine is of the semi-double-flow construction, in which the steam flowing toward one end (about one-third of the total) passes through sufficient stages of blading to be exhausted at the final condition of two vertical condensers, while the other two-thirds of the total steam flow pass through fewer stages of blading, to be carried thence by a receiver pipe to the inlet of the low-pressure turbine. The low-pressure unit is also of the double-flow construction and exhausts into four vertical condensers.

The reduction in last row annulus due to the subdivision of exhaust area afforded by the divided-flow arrangement makes it possible to operate the intermediate and low-pressure units at 1800 r.p.m. It has been found possible to dispense with the blade ring construction, all the stationary blading being carried in the cylinder proper. The resultant simplification of the cylinder construction is accompanied by a considerable reduction in the unit turbine weights. This tends to offset to some degree the increase in weight due to the addition of the intermediate-pressure turbine, in as much as the low-pressure turbine, if it took the entire steam flow, would have to be a 1200-r.p.m. machine because of last blade row limitations.

TURBINES FOR INDUSTRIAL PLANTS

There has been evidenced in the past year a growing recognition on the part of various industries of the economies to be achieved by the proper application of special types of turbines in connection with the use of low-pressure steam for process requirements.

*Westinghouse Electric and Manufacturing Co., South Philadelphia Works.

One such application will be described in some detail in the technical press and consists of a turbine designed to operate with steam or 725 lb. gage inlet pressure, with 700 deg. F. total temperature and to exhaust at 165 lb. into a header supplying steam for a technical process and for other plant apparatus. This machine embodies a number of unique features but lack of space prevents a description in this article.

Another special turbine worthy of note is a unit which is employed to heat feed for an entire plant. This machine is arranged to be bled at three points, and it exhausts into a low-pressure heater instead of a condenser, so that the total steam flow of the unit is employed in heating feed.

A governor of the hydraulic type is provided, actuated by oil pressure created by the centrifugal force of a column of oil in an impeller mounted on the turbine shaft. This in itself constitutes an achievement of no small importance. A back pressure regulator controls the governing oil pressure and so adjusts the inlet valves as to maintain a constant pressure in the high temperature heater. In this manner, the steam flow of the unit is regulated to maintain constant feed temperature regardless of electrical load fluctuation.

Combination Impulse—Reaction—Bleed and Mixed Pressure Turbine

A recent application of interest is that of a combination impulse and reaction turbine from which all the steam is bled from the impulse wheel chamber into a high-pressure process steam line while steam from a low-pressure line is bled back into the reaction stage of the turbine in sufficient quantity to enable the unit to carry the load. Both outward and inward bleeding are automatically controlled and in addition a bypass is provided, controlled by an automatic valve connected to the governor system. In case of lack of low-pressure steam to feed the reaction portion of the turbine this valve bypasses enough steam around the diaphragm to satisfy the turbine load condition.

In connection with advances in turbine practice one improvement in surface condenser design may be mentioned.

Condenser Development

Manufacturers have sought a means of doing away with condenser tube packings. The first step in this direction was the expedient of rolling tubes in one tube sheet in order to halve the packing trouble. Next the sliding head was devised so that both ends might be rolled without danger of injury by differential expansion. The latest development is the employment of a flexible metal diaphragm between the tube sheet and condenser shell. This eliminates the sliding head with its attendant sealing difficulties and permits tubes to be rolled at both ends and still expand freely without disturbing the water tight integrity of the shell and tube sheet connection.

Modern Superheater Problems

Three Types of Superheaters Have Been Developed to Meet New Combustion Conditions. By W. F. Keenan, Jr.*

HEAT IS TRANSFERRED to steam in a superheater by radiation, convection and conduction. The two principal methods of transfer to be considered in design of superheaters are radiation and convection.

Royds in "Heat Transmission by Radiation, Conduction and Convection" (Van Nostrand, 1921) discusses the transfer of heat by radiation as follows:

"The phenomena of heat and light are essentially associated with matter. According to accepted theories of the constitution of matter it is assumed that all matter is made up of molecules and atoms. These atoms and molecules, or at any rate some portion of them are further supposed to be in a violent state of vibration, oscillation, or agitation which is associated with what we call heat and light. It is assumed that these vibrations or oscillations set up waves which travel at an enormous velocity, something of the order of 186,000 miles per second in vacuo. These radiations, however, only become evident to our senses when the waves impinge on sympathetic particles or molecules of matter. That is, if the molecules are so constituted that they, or some portions of them, respond to the impinging waves, or, in other words, if their natural period of vibration or motion is in "tune" with these waves, the waves are extinguished and vibration is induced. Otherwise the waves pass on or are reflected, apparently leaving the molecules unaffected.

A radiating body, however, being composed of innumerable molecules, each with vibrations according to its nature and temperatures, generally sends out radiations of various wave lengths. An incandescent body, for instance not only sends out light waves of various wave lengths, but also heat, which has wave lengths relatively longer than those of light. In any case, the radiation of light and heat are similar, those waves constituting light being short, those of heat relatively long. Conclusive evidence of this similarity is furnished by the fact that heat radiations obey the same laws of reflection, refraction, polarization, and interferences as light radiations. The apparent difference merely arises from the fact that they affect our senses differently."

Referring now to the transfer of heat by convection. The term convection means that heat is carried by a fluid and not by electro-magnetic waves. In convection superheaters, for instance, heat is carried by the gas to the outer surface, then transferred by conduction through the metal, finally being absorbed and carried away from the inner surface by the steam.

Considerations in the Design of Radiant Heat Superheaters

In the application of radiation formulas to the design of radiant heat superheaters these considerations are important. First, radiation to the superheater depends on temperature, position, and radiating properties of the flame. Second, the greater the amount of heating surface exposed to radiation the lower the temperature and the less the transfer of radiant heat per unit of surface exposed. Third, the higher the rate of combus-

*Chief Engineer, Power Specialty Co.

tion the greater the weight of gases to be cooled and the less the proportion of total heat carried off by radiation. Fourth, the less the dilution of flame by air, i. e. the higher the CO_2—the higher the temperature and therefore, the heat transfer by radiation. In practice the only way in which the many controlling factors and laws can be reduced to working formulas is from actual results obtained in furnaces and with fuels similar to those under consideration in any particular case.

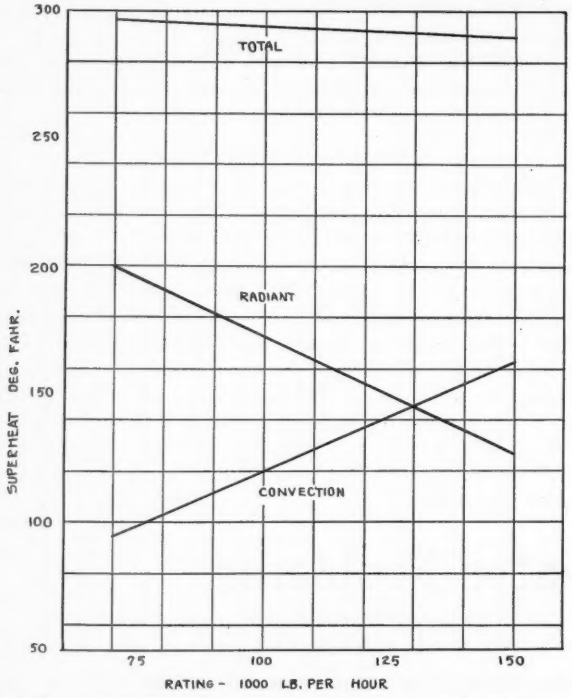


FIG. 1. SUPERHEAT CURVES FOR RADIANT AND CONNECTION TYPE SUPERHEATERS INSTALLED IN THE OMAHA PLANT OF NEBRASKA POWER CO.

From the third of the four above-mentioned items affecting radiant heat superheater design, note that as the rating increases the proportional heat absorbed decreases, therefore, the superheat decreases. This characteristic is used to advantage in installations where radiant superheaters are installed in combination with convection superheaters having opposing characteristics which show an increase of superheat with rating. In such combinations very flat curves of superheat over wide ranges of rating can be obtained as shown in Fig. 1, which is a curve of actual results from combination radiant and convection superheaters installed in the Omaha plant of the Nebraska Power Co. These superheaters are installed in 1850-hp. Babcock and Wilcox cross drum boilers fired with coal on chain grate stokers.

The heat absorbed per unit of convection superheater surface is the rate of heat transfer in B.t.u. per hour per square foot per degree mean temperature difference times the effective mean temperature difference between gas and steam. The rate of heat transfer is a function: First, of the mass flow, that is the rate of gas flow in lbs. per hour per sq. ft. of gas area through superheater; second, of the specific heat, conductivity and viscosity of the gas; third, of the size and shape of the heating surface.

Formulation of rules for the design of convection superheaters is a simpler problem than for radiation superheaters but the relation between the heat transfer and these variables must be determined by experiment. The outstanding difficulties in modern convection superheater design problems have to do with these conditions:

1. Improved combustion conditions with high CO_2 and therefore low gas weight per pound of fuel fired have—other conditions being equal—reduced not only the weight of gas per pound of coal and gas, but also the temperature of gas at the superheater.

2. High feed-water temperatures entering boiler resulting from use of economizers or stage bleeding of turbines by reducing the heat to be added per pound of steam have also reduced the weight of coal and gas per pound of steam.

3. Use of waste heat recovery equipment—economizers or air heaters—has increased overall efficiencies and reduced gas weights per pound of steam.

On the gas side under typical modern conditions smaller quantities of gas at lower temperatures are

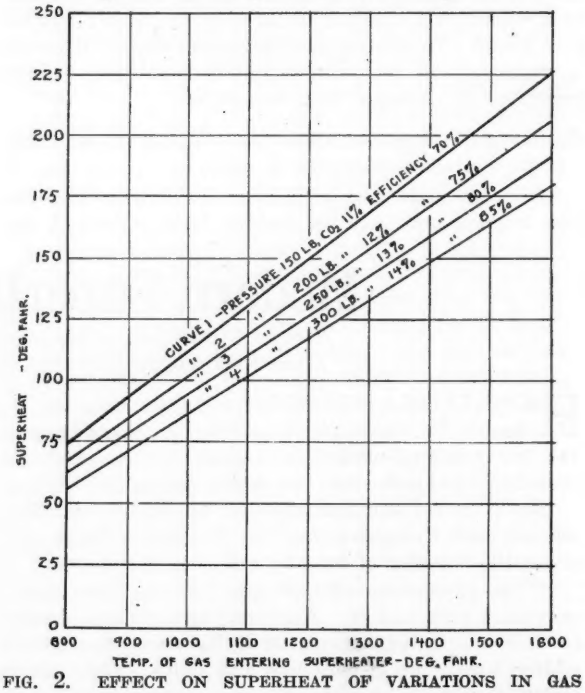


FIG. 2. EFFECT ON SUPERHEAT OF VARIATIONS IN GAS TEMPERATURE ENTERING SUPERHEATER, STEAM PRESSURE, CO_2 AND OVERALL EFFICIENCY. HEATING SURFACE PER LB. OF STEAM AND RATE OF HEAT TRANSFER CONSTANT AT ALL POINTS ON ALL CURVES

available for superheating. On the steam side greater superheat is called for, most specifications requiring a steam temperature of 700—725 deg. F. instead of 550 deg. or less, which was not uncommon only a few years ago. Reducing the quantity of gas and at the same time increasing the amount of heat to be added per pound of steam increases the gas temperature drop through the superheater and reduces in somewhat greater proportion the effective mean temperature difference and increases in inverse proportion the amount of surface required to produce the same superheat under typical new and old conditions. Figure 2 is a set of curves that show—assuming same heating surface and same rate of heat transfer at all points on all four curves—the net effect on superheat obtainable of variations indicated in gas

temperatures entering superheater, steam pressure temperature, and superheat, feed-water temperature entering boiler, CO_2, and efficiency of boiler and superheater. Curve 1 conditions are typical for not many years back and Curve 2 conditions are typical for today. It will be observed that the same superheater that was good under Curve 1 conditions for 150 superheat with 1100 deg. gases entering superheater with 1000 deg. gases would be good for only—superheat under Curve 4 conditions. It is estimated that under Curve 4 conditions gas temperature entering superheaters would be at least 100 deg. less at the same load than under Curve 1 conditions.

The importance of the superheater in the power plant field was securely established years ago and with the advent of the steam turbine as the standard prime mover for electric generators the superheater became and still remains an absolutely essential part of the steam generating unit. The demand for higher superheat coupled with improvement in design and performance of other parts of the steam generating unit have necessitated changes in superheater practice and design. It would be impossible within the limits of this article to discuss the relative merits of the different types of superheaters that have been developed by various manufacturers to meet present day requirements. Let it suffice to say:

First, that such requirements cannot be met with convection superheaters even of prohibitive size in many locations heretofore considered standard such as the top of first pass in a horizontal water tube boiler vertically baffled.

Second, that to overcome this difficulty three distinct types of superheater have been developed:

1. Interdeck convection in boiler tubes near furnace.
2. Combination convection in standard location in series with small radiant section in furnace.
3. All radiant superheater in furnace.

Third, each one of these three types has its good points and is under certain conditions the one to be preferred. A careful study of the general design and performance requirements of the steam generating unit as a whole would necessarily precede an intelligent selection of the type superheater that should be used on any particular job.

New Features at Rummelsburg Super Station

Bleeder Steam for Preheating and Coal Drying Are Some of the Interesting Features of This German Plant

SOME of the designing and operating theories which the late G. Klingenberg sets forth in his recent edition of "Bau grosser Elektricitaetswerke" being applied to the Berlin super station Rummelsburg which he designed and which is now under construction. According to an article describing this plant in the V. D. I., the ultimate capacity of the plant which adjoins the river Spree will reach 500,000 to 600,000 kw. To begin with, there will be three main turbines of 70,000 kw. each and three preheat turbines of 10,000 kw. each.

The central station will operate at a temperature of 415 deg. C. (779 deg. F.) and a pressure of about 35 atmospheres (514.36 lb.) at the boilers. Of course there will be no stage superheating. Comparative estimates for Rummelsburg indicate that operation at 35 atmospheres is economically best in view of the thermal results obtainable. Above this, pressure boilers, piping and other apparatus, as built in Germany, require considerable alterations. Following the example of the Bruenner Maschinenfabrik, nearly all German plants operate now at lower steam velocities. The designer of Rummelsburg considered 10 to 15 per cent moisture in the steam safe under this lower velocity.

Bled Steam Preheats Feed Water

For obtaining highest thermal efficiency, steam for preheating feed water has been bled from turbines at three or four places. In more recent practice, to simplify the equipment, steam is bled from turbines only at two places. For the sake of greater safety, however, the main steam turbines at Rummelsburg are not tapped at all. Steam is bled from so-called preheat turbines which are comparatively simple and small, operate at 3000 r.p.m. and are just large enough to supply all the steam needed for preheating the feed water.

Still lower installation cost and safer operation is assured by placing the preheat or bleeder turbines, the feed water distilling apparatus and the boiler feed pumps in a low building between the boiler houses. The distilling apparatus preheats also some of the water. The preheat turbines, being independent producers of energy and used as house turbines, drive the feed water pumps and deliver their surplus energy through double safety automatic switches to the main generator bus.

Boilers are selected with a view to safe first cost by reducing their height as much as possible and by building the entire unit as compact as possible. Large units are selected to obtain high efficiencies per square foot area.

Powdered fuel-fired plants are not so dependent on the quality of coal as are stoker-fired plants, but they require elaborate coal drying equipment. A water content of 2 to 12 per cent and even to 20 per cent in the German coal requires extensive drying of coal for pulverizing.

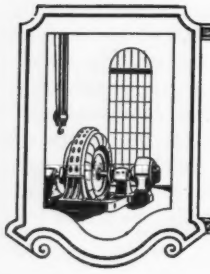
The direct-heated coal drying drums now used in Germany will soon be discarded. Drying with flue gases has not been practiced in Germany but for years the highly developed German brown coal industry has employed drying drums heated by exhaust steam.

At Rummelsburg steam is bled from an intermediate stage of the steam turbine at about 2 atmos. (29.392 lb.) over-pressure and delivered to the coal dryers through an easily regulated steam valve. The condensate is returned to the circulating system of the plant. The dryers are so compact that they are placed directly beneath the coal bunkers, thus eliminating elevating of the coal.

At present 16 boilers are installed, each having 1600 sq. meters (17,222.4 sq. ft.) water-contact heating surface and 150 sq. meters (1614.6 sq. ft.) cool-heating surface in the furnace rooms.

There are three twin steam turbines of 70,000 kw. each, a high pressure and medium pressure group of 35,000 kw. and a low pressure group with divided low pressure section also of 35,000 kw. both for 1500 r.p.m. operation. At the turbine steam pressure is 32.5 atmospheres (477.52 lb.) and steam temperature is 400 deg. C. (752 deg. F.).

The six main generators of 44,000 kv.a. capacity each produce at 1500 r.p.m. a voltage of 6000 each.



ELECTRICAL MACHINERY FOR LIGHT AND POWER

Generator Practice in Central Stations

A Discussion of the Considerations Involved in the Arrangement of Generators and Auxiliaries in Modern Power Stations. By M. J. Lowenberg*

WITH THE RAPID increase in the use of electrical energy there has been created a demand for larger and larger generating units combined with increased efficiency. The proper size of generating unit for a given station should be determined only after a careful estimate and study of the probable growth of load over a period of not less than 10 yr. An accumulative annual cost analysis, using different units, should also be made, from which the most economical size may be selected. This size is usually one that requires the installation of a unit about every two years in a normally growing base load station. If the system extends over a large territory and the increase in load is to be divided over more than one station, then the analysis should include transmission cost. The economic size of the unit will be affected by the amount of relay required, the cost of land, the nature of load, load factor, and probable trend of fuel cost.

At present structural considerations have limited the size of single generators to about 100,000 kv.a. In the case of larger generating units and in many smaller units, two or three generators have been used.

The size of the unit selected, however, should be such that the loss of the largest unit will not curtail the energy supply to prime power customers. If at the peak there is a large load that can be interrupted for several days, such as irrigation pumping, then this load can probably be omitted in determining the relay capacity required. In estimating the annual costs, it is necessary to consider a possible change in fuel as well as fuel costs. Many stations are operating today on natural gas or fuel oil that may be required to change to some other and more expensive fuel.

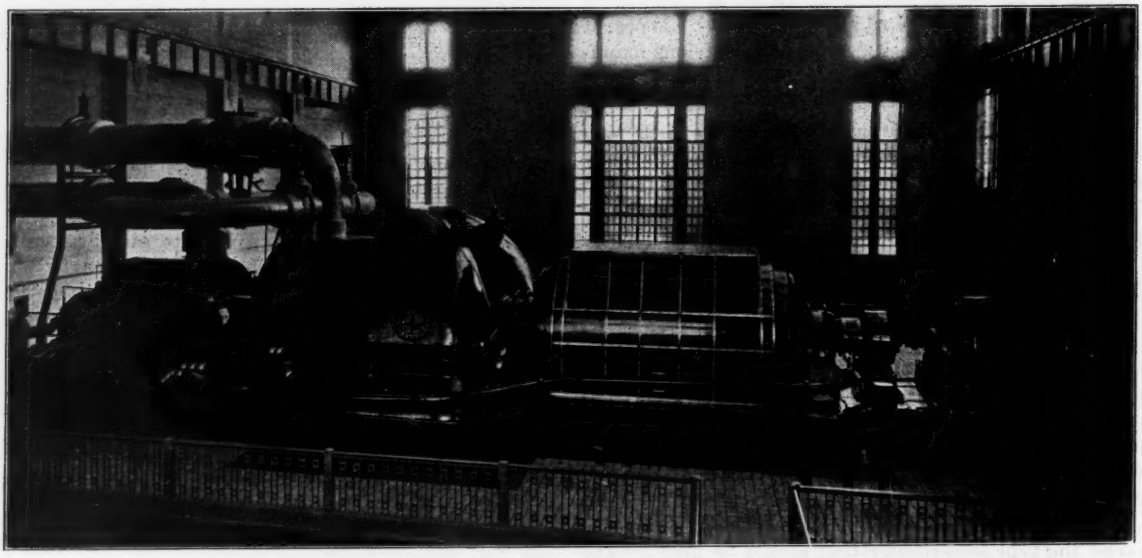


FIG. 1. TYPICAL EXAMPLE OF A PLANT WITH THE GENERATING UNITS INSTALLED WITH THE AXES AT RIGHT ANGLES TO THE BUILDING AND HAVING DIRECT-CONNECTED AUXILIARY GENERATORS

There is no standard practice in regard to the arrangement of electric generators and their auxiliaries. Various arrangements have been adopted to conform to conditions peculiar to the individual station. In most of the recent power stations, however, the turbine room has been located between the boiler room and the electrical equipment, the latter either being housed or located outdoors.

In general, the arrangement of turbo-generators

*Electrical Engineer, Stone & Webster, Inc.

within the building follows one of two plans: first, with the axes of the units at right angles to the length of the building and, second, with the axes of the units parallel to the length of the building. Where the right angle arrangement is followed, the generator end of the unit is located next to the electrical switching equipment, thus reducing the length of the generator leads to a minimum and permitting the arrangement of all generator accessories at the same side of the turbine room. Where the parallel scheme has been followed, there is considerable advantage in arranging the units in pairs with the generator ends adjacent. This permits the use of a common withdrawal space for generator rotors, thereby reducing the length of the turbine room; permits the generator leads from each pair of machines to be carried from the building in a common tunnel structure; and permits all generator accessories for both units to be grouped together, thereby resulting in greater operating convenience and reduced construction cost. Another advantage of this arrangement is that high pressure steam leads to the turbines are kept at a maximum distance from the electrical generators.

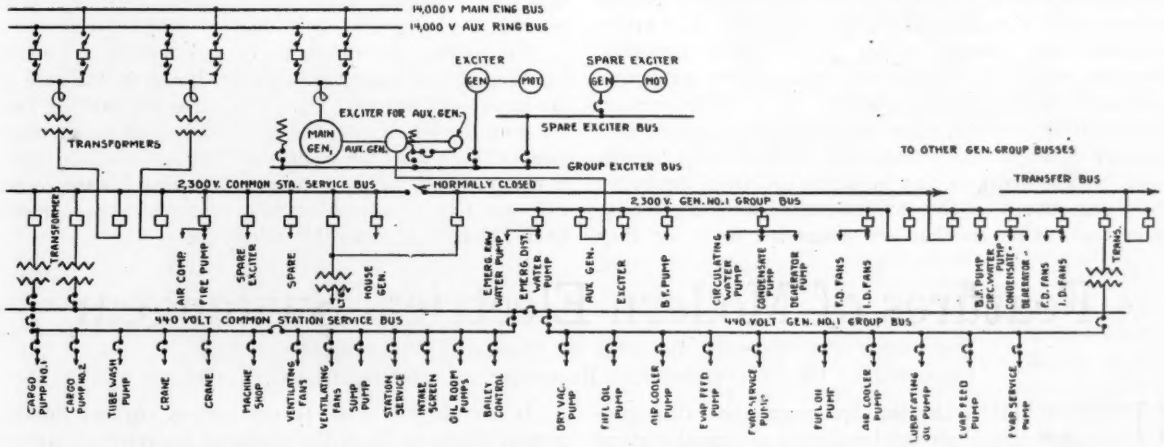


FIG. 2. ONE LINE DIAGRAM SHOWING AUXILIARY AND HOUSE SERVICE SUPPLY IN A GENERATING STATION

Generator auxiliaries, which comprise air coolers, field rheostats, neutral resistors, neutral current transformers for differential protection, neutral oil circuit breakers, and the field rheostat of the auxiliary generator, if the latter is used, are located adjacent to the generator end of the unit, the exact arrangement depending somewhat upon the size and type of equipment used.

Whether the generating units should be placed crosswise or longitudinally in the turbine room, is a subject for careful study and depends to a great extent on the number of boilers per turbine and the size of the boilers.

Method of Driving Auxiliaries

Analysis usually indicates that in a high efficiency station, station auxiliaries driven electrically rather than by steam are preferable because of greater economy and operating flexibility. Maximum reliability must be obtained, requiring the source of supply for the auxiliaries to be independent of system disturbances. For electric drive, this necessitates a supply from a house turbo-generator or from a generator on the same shaft as the main unit. The auxiliary load will usually be approximately 3 per cent of the rating of the main unit for normal steam pressure plants, with a power factor varying from 70 per cent to 85 per cent.

The use of an auxiliary generator coupled to the shaft of the main unit is increasing as this arrangement is compact, reduces the number of steam connections, and is more economical as it generates power with the efficiency of the main unit turbine. It also provides a high degree of power supply reliability for the auxiliaries of each turbo-generator with its portion of the boiler room auxiliaries and is simple to operate.

Choice of Voltage for Auxiliaries

The choice of the voltage for the auxiliaries depends largely on the size and number of motors involved. In a steam plant having large units with most of the motors rated above 100 hp., it appears that 2300-v. motors for all over 25 hp., with 440 or 550 v. for smaller motors, gives the most economical arrangement. A lower voltage for all motors means unusually large conduits and cable for large capacity motors resulting, in the case of concealed work, in heavy and expensive construction for the floors and supporting members, the cost of which offsets the saving due to the less expensive lower voltage switching. In hydraulic stations where the motor equipment is relatively small, a low voltage, such as 440, appears to be suitable.

Relaying the Normal Power Supply

Whatever voltage is adopted for the station auxiliaries, means must be provided for relaying the normal power supply. Equipment must be automatically disconnected from the normal power source when that fails and supplied from some other source, such as station service transformers fed from the main bus. A simple and flexible system is shown on the accompanying one-line diagram.

A few words explaining the one-line diagram may be of interest. Each main turbo-generator has a 2300-v. group bus which is supplied normally from an auxiliary generator coupled to the main generator shaft. To this bus are connected all the auxiliaries for this turbo-generator and, in addition, its portion of the boiler room auxiliaries. All motors of 40 hp. and larger are wound for 2300 v. and smaller motors for 440 v. The 2300-v. switch gear consists of truck type panels and breakers.

The group bus is sectionalized so that one-half the auxiliaries are on each side.

In case of interruption of power supply from the auxiliary generator due to its failure, a relay automatically opens its oil circuit breaker and then automatically closes a breaker which connects this 2300-v. group bus to the common station service bus supplied through transformers from the main bus. In case of a short circuit on that section of the group bus which is connected to the auxiliary generator, a relay functions, opening the bus sectionalizing breaker and the auxiliary generator breaker and closing the breaker to the common station service bus which is connected to the group bus on the other side of the sectionalizing breaker, thus permitting one-half the auxiliaries to continue in operation. If, at times, the boilers in operation are not those whose auxiliaries are connected to the generator in service, then it is possible, through the transfer bus, to transfer this auxiliary boiler room load to the generator in service. This transfer bus may be of insulated cable with differential relay protection to clear it in case it should fail.

The 440-v. generator group bus is normally supplied through its own 2300/440-v. transformer, but is relayed through a 440-v. common station service bus. The 440-v. switching may consist of air break circuit breakers. Breakers which have to do with the supply of power such as the auxiliary generator breaker, exciter breaker, sectionalizing breaker, common station tie breaker, and transfer tie breaker, are controlled from the switchboard room. Other breakers may be controlled from the boiler room gage board or the turbine gage board, depending upon the auxiliaries that are connected to it, or they may be manually operated at the switchboard. Switching for non-important station auxiliaries is usually handled at the common station service board.

The excitation bus arrangement depends somewhat upon whether or not an exciter battery is used. Such a battery, for emergency supply operation, has been installed in a few stations. Each exciter is rated sufficiently large to take care of the largest generator and the number of exciters corresponds to the number of generators, plus a spare. These exciters feed directly into duplicate exciter busses.

Where battery excitation is not used, a direct-connected exciter for each auxiliary generator and a motor-driven exciter for each main generator, with one spare set, provides a reliable layout. In order to obtain the proper voltage regulation for the service motors, a face plate rheostatic regulator or a Tirrill regulator is used for control of the auxiliary generator voltage.

There has been an increasing tendency to improve the reliability of generator connections. In most of the large stations the main generator leads are run with insulated cable or copper on insulators and differential relay protection for generator windings and leads is in general use.

For cooling generators the closed type of air cooler has been almost universally adopted, and in the case of the larger generators (50,000 kw. or over) outside fans are used for circulating the cooling air. In the arrangement of fans and air coolers attention should be given to compactness. This arrangement makes it easy to use CO_2 gas for extinguishing any fires which may result from failures in generator windings.

Features of Modern Electrical Switchgear

Discussing the Factors Involved in Designing Switchgear to Meet Present-Day Heavy Interrupting Requirements. By Gilbert C. Lamb*

UNTIL WITHIN the last few years the full importance of the oil circuit breaker in electrical systems has not been appreciated. During the past few years, however, much progress has been made in the use of electric power which has resulted in many changes in distribution systems, interconnections, and generating stations. These changes have introduced complications not only in the design and construction but also in application of proper protective apparatus. Operators as well as manufacturers have followed with interest the results of power growth, the availability and the development of large and efficient equipment.

Increasing requirements for switchgear of higher interrupting capacity ratings, capable of meeting the severe duty often imposed has led to a steady improvement in design and construction.

Relation of Various Parts in the System Important Consideration

In determining the fundamentals, one of the chief considerations is the relation of connections between the generating system, the station feeder busses and the substation distributing systems. The interconnection may be such that careful analysis will be essential in checking the large units of power handled and the concentration of that power at the time of a short circuit.

It may be advisable to use certain current limiting means available in order properly to apply protective apparatus best suited for the application. Again, it may resolve itself into considering the highest rated interrupting capacity breakers procurable.

It has been said that the essential determining factor with regard to installing new substations and distribution lines is whether the return on the investment would warrant the cost of the building, copper, equipment and maintenance.

Oil switchgear with adequate protection for the larger stations and systems is important and as some have expressed it, the "backbone" of the electrical control. On it depends the continuity of service, a vital factor in the life of any industrial or central station. As systems, stations and equipment grow in size, breakers have become larger and their importance likewise increased.

The thorough analysis required in the application of certain types, impresses one of the continued need of efficiency in circuit-breaker operation as required in other important units of electrical apparatus.

As in the improvement in turbine efficiency to the extent that older types have been replaced by newer types of considerable increased capacity without making an appreciable increased demand space requirements, so have there been such strides made in circuit-breaker

*With Condit Electrical Manufacturing Corp., a subsidiary to American Brown Boveri Electric Corp.

construction as to have increased interrupting capacity available without necessarily increasing the space given over for an original installation. This has often proved extremely advantageous in the modification of existing stations where switchgear of higher ratings had to be installed in the comparatively limited amount of space.

Again, station extensions and new projects have required switchboard and breaker installation so combined as to permit the greatest amount of safety, ease of operation, maintenance and control, all with minimum cost.

Considering the Destructive Forces Liberated in the Breaker

In considering oil circuit-breaker design the destructive forces liberated in the breaker at time of short circuit must be taken into account.

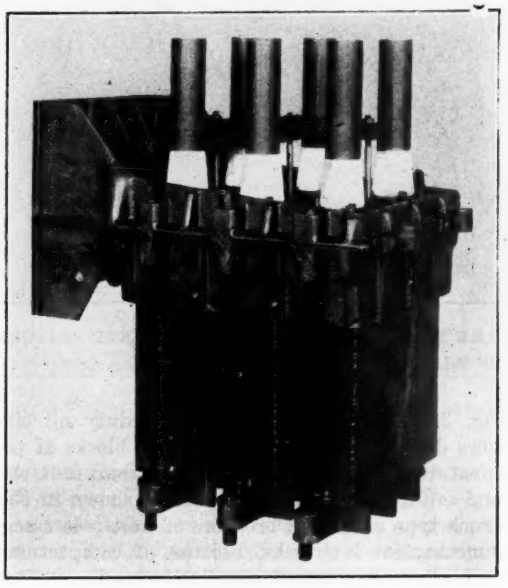


FIG. 1. A 3-POLE, 15,000-V. OIL CIRCUIT BREAKER SHOWING RIGID COMMON FRAME

In general, this may be expressed under three classifications of energy loss: 1, Mechanical; 2, Chemical; 3, Thermal.

It can be assumed that the mechanical forces set up by the internal pressures at time of initial establishment of the arc results in stresses due to the rapid displacement of the oil by the arc. These forces may be manifested in bulged sides and bottoms of the tanks.

Mechanical forces which may result in tank bulging in breakers having high head of oil and improper tank design may be offset so as to reduce the seriousness of such difficulties by taking into consideration a balanced head of oil, with reference to tank shape and thickness.

Balanced head of oil neutralizes these forces, followed by the establishment of the arc, and therefore the energy is not likely to result in bulging that might occur should there be too high oil head.

The chemical effects of gases rising to the surface of the oil and mixing with the oxygen may result in an explosion creating high pressures. At times such pressures may be developed as to rupture tanks, bolts or fastenings, bushings and the tank top.

To obviate such difficulties a heavy constructed frame of ample proportion to secure rigidly in place the stationary current carrying parts and porcelains would be in line.

The thermal factor due to current inrushes of high value or with abnormal loads involve heating to the stud assemblies and brushes of a breaker. The results of such thermal effects may be burning of the brushes or contacts, depending upon amount of current and the length of time the load may be experienced.

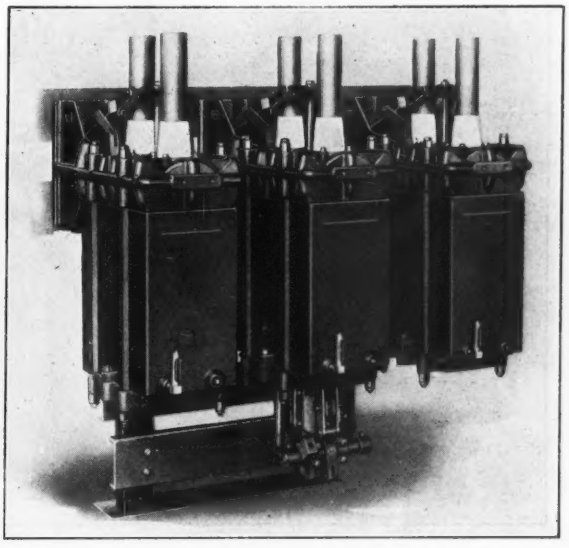


FIG. 2. A 3-POLE, 15,000-V. UNIT POLE OIL CIRCUIT BREAKER

A circuit breaker must not only carry its rated current capacity within certain specified limits but must be able to withstand current inrushes which may reach a value many times its normal continuous current carrying capacity. Heating varies with the square of the current.

From this it follows that the temperature in the conductors may reach a value which through expansion places a strain on the conducting parts. These strains acting with the electro-magnetic forces may result in enormous momentary stresses.

In line with the well-designed apparatus, there should be a liberal factor as to brushes, studs, bushings and clearance under oil.

It is obvious that the value of a frame which adequately reinforces the tank sides must not only have strength, but rigidity as well to support the mechanism thoroughly, and tanks with supports or cradles.

It is the intention in a general way to point out only such advanced types as it is felt may be of major interest. Figures 1 and 2 are indicative of rigid designs.

The value of speed of arc interruption is of great importance. Its significance can be understood when it is realized that: Speed of contact separation is a factor in determining energy loss.

Contact separation may be accomplished by means of: High-speed mechanical break. Rush (pressure) of gases against the arc. Multi-series break.

It is felt that the surest and safest way to secure this high speed of arc interruption is by means of the multiple series break.

Many desirable features are accomplished in its use.

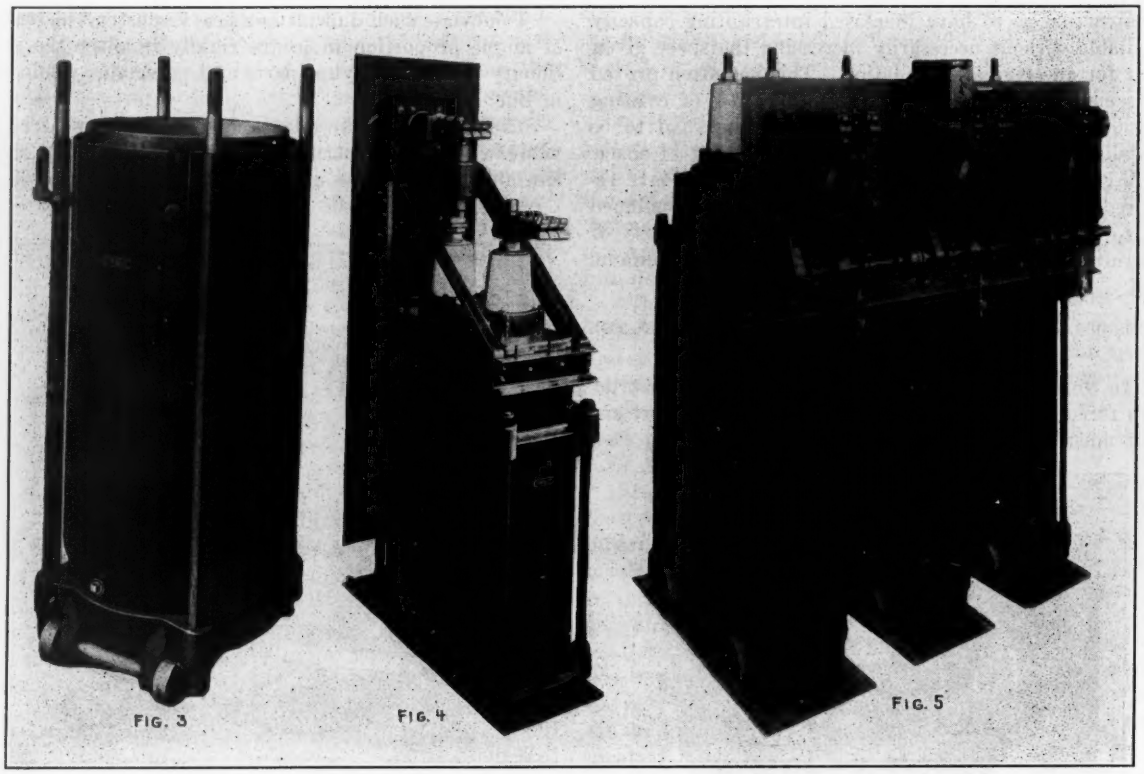


FIG. 3. DOUBLE TANK CONSTRUCTION USED TO PREVENT FLAME THROWING AND HAVING RESILIENCY FEATURES
FIGS. 4 AND 5. TWO BREAKERS OF THE TRUCK TYPE

Included in these features are: Shorter duration of arc. Smaller amount of gas generated. Smaller dissipation of arc energy.

It is generally realized by operating engineers that breakers for high interrupting capacity duty must be especially strong in order to take care of the short circuit conditions within the breaker. It is because gases liberated within the breaker in a very short time create an increase of pressure.

Now if a shorter time of arcing can be obtained, then a smaller amount of gas will be generated. This infers that with application of the multiple break, the most desirable and effective means in circuit interruption is employed.

Assuming an average speed in brush rod travel of 7 ft. per sec., there would be, using four breaks in series, theoretically 4 times 7, or 28 ft. per sec., as speed of break. Similarly with six breaks, speed of break would be 42 ft. per sec.

Elimination of Flame Throwing

Too much attention cannot be given to the elimination of flame throwing. It is possible through proper design to apply compact equipment capable of interrupting large amounts of power and to accomplish this with such energy absorption principles as greatly to reduce hazards, at the same time affording the greatest factor of safety.

Some of the advanced types of breakers have effectually demonstrated the value of such features in design as the double tanks and the application of the resiliency feature. These features are possessed by the unit, shown in Fig. 3. Example of extra heavy duty oil circuit breakers designed to handle the largest blocks of power with features embodying the unit pole, dual tank assembly and multi break for the contacts is shown in Fig. 6.

Truck type oil circuit breakers of unit pole assembly with mechanical interlocks, because of compactness of design lends to economical installation, and can often be used in existing cell structures where increased rating is required without making material changes in the layout.

Mechanical interlocks between the pole units of universal type of coupling readily permits disconnecting a pole unit, rolling out of place and allowing spare units to be quickly put in service. For special applications the studs can be equipped with automatic disconnecting switches. This arrangement has been found desirable where the space factor does not permit the ordinary installation of disconnecting switches.

Although these breakers may be essentially truck type, they can be furnished for platen mounting, a tank lifter being used for dropping the tanks to the floor and rolling out of place.

All the basic principles of design as embodied in the larger types of indoor breakers are incorporated in the larger types of outdoor breakers.

Outdoor breakers must be thoroughly weather proof, particularly with respect to the heavy cast tops or insulator support. For moderate voltage outdoor breakers, 73,000 v. or less, unusually strong structural supports are desirable to securely support the heavy pole unit assembly and mechanism.

Bushings with proper flashover characteristics to

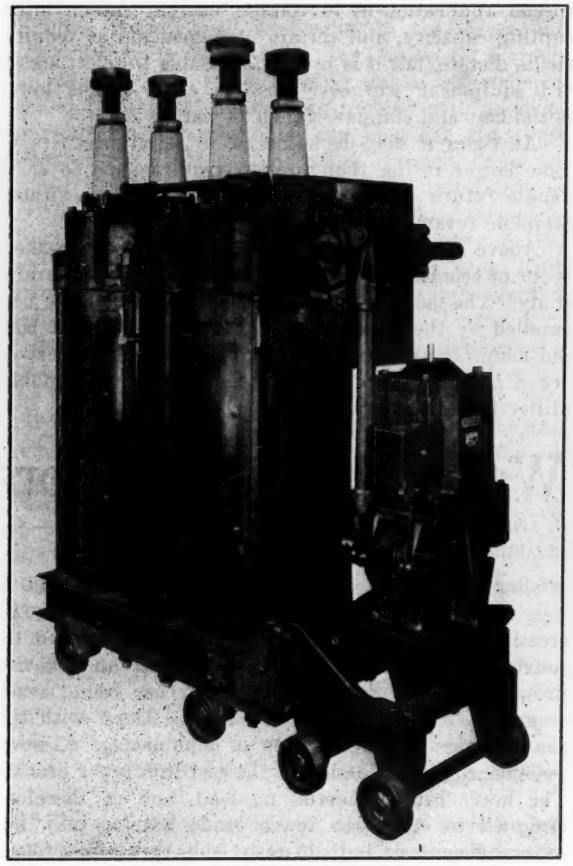


FIG. 6. DUAL TANK ASSEMBLY TRUCK TYPE BREAKER, 15,000 v.

meet local requirements are essential. A few examples of 15,000-v. to 73,000-v. breakers are shown in Fig. 8.

As tank diameters are increased, the area exposed to pressures is also increased, and it is only natural that tank tops for such apparatus must be proportionally heavier than for smaller equipment in order that the

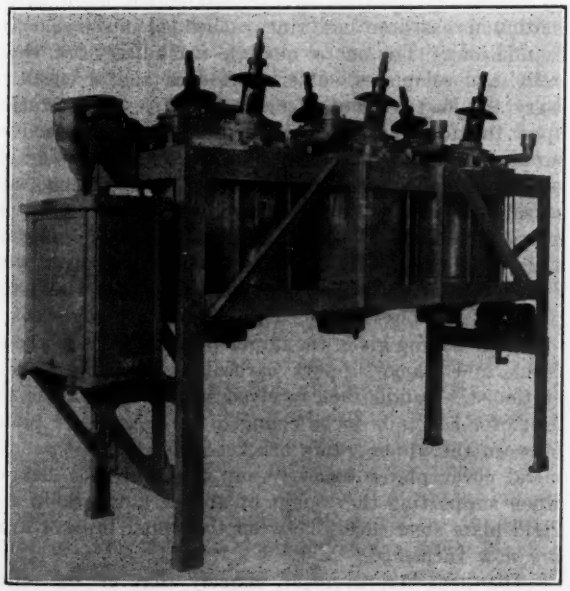


FIG. 8. A 37,000-v. OUTDOOR OIL CIRCUIT BREAKER

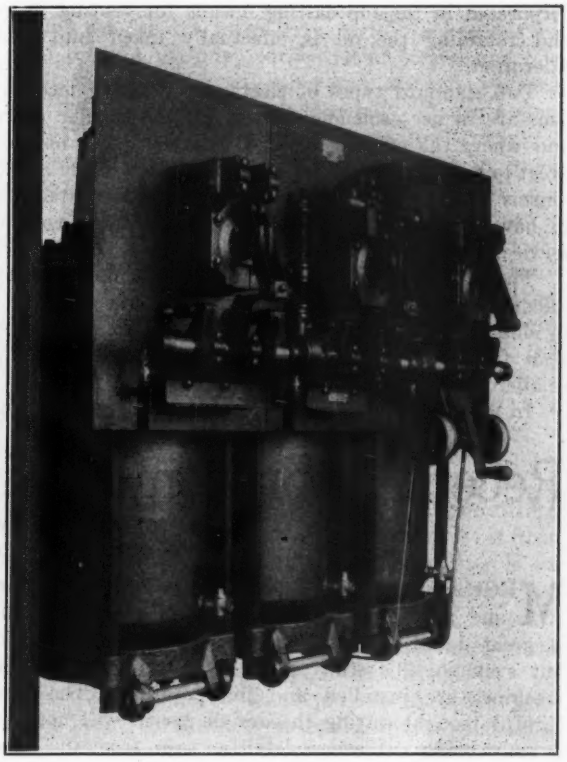


FIG. 7. PLATEN-MOUNTED 15,000-v. BREAKER SHOWING APPLICATION OF TANK LIFTING AND TRUCK ARRANGEMENT

mechanism support, bushing transformer, well arrangement, and supporting area of the bushings will present the greatest resistance possible to forces liberated under short circuit or abnormal conditions.

The successful application of the multi-break in large outdoor circuit breakers, in addition to features already brought out, permit a shorter stroke. This is exceedingly desirable, as it permits a much better designed mechanism to be employed without reduction in oil clearances either to ground or between contacts.

Either through pressure vents or other designs in-

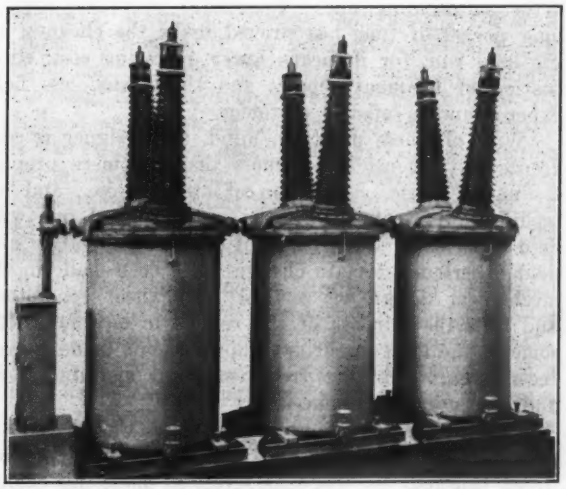


FIG. 9. A 132,000-v. OUTDOOR OIL CIRCUIT BREAKER ARRANGED FOR MOUNTING WITH TRUCKS FOR STANDARD RAIL GAGE

corporated in the top casting, means for venting gases and retaining the oil is effectually taken into consideration.

Two standard types of electrical operating mechanisms are in use—solenoid control for the smaller types and where the current required for control is not too great to be at a disadvantage, and motor operating mechanisms for large breakers or where it is advantageous to have a comparatively light demand on the control service.

The largest high voltage breakers, if operated by solenoids, might require considerable amount of current to close—so much, in fact, that it would be more practical to consider a.c. or d.c. motor control requiring smaller current demands.

In general oil circuit breakers may be developed for special application as to voltage, current rating, interrupting capacity, and certain arrangements as requirements dictate, but it is usually advisable to select standard equipment whenever possible as it means lower initial cost and standardization of parts.

At times it may be essential to select breakers of some larger rating than present requirements so as to handle future increased capacity of the system without complete revamping of the station.

Above all, the proper selection of oil circuit breakers is one of economy. It is a subject often requiring careful study. The more difficult problems can at times be best handled by the co-operative effort on the part of both the manufacturer and the user. Such benefits derived are of great value to the industrial as well as the public utility field.

Recent Improvements in Waterwheel Generators

EXPERIENCE IN THE OPERATION OF WATERWHEEL GENERATORS HAS RESULTED IN A NUMBER OF IMPROVEMENTS, ALL OF WHICH ADD TO THE RELIABILITY OF THE MACHINES. BY R. PRUGER*

MECHANICAL DESIGN features of electric motors and generators are studied with great care and in great detail while the machines are being designed, but even so, this study must be continued after the machines are installed and in operation. The most careful thought during the design period will not necessarily bring out every detail as seen from the operator's point of view—partly because the designer's experience may be limited in so far as actual operating conditions are concerned, and partly because new ideas are oftentimes developed during operation. The designer is, therefore, rarely in a position to claim that the acme of perfection has been reached, for even if such a position were reached, or approached, new field requirements might make it necessary to modify previous designs. In addition, there is the item of competition. This may mean the elimination or simplification of certain parts, reduction of weights wherever possible, or it may be a step in the opposite direction, adding features, strengthening some parts, as dictated by field experience and careful observation. While manufacturing cost is always an important factor, it is not altogether a deciding one. Successful operation over a long period of time has proved to be the cheapest in the long run, for it means lower operating cost, elimination of frequent repairs and shutdowns, less field expense and a satisfied customer.

With all these points in mind, the designer is confronted with considerably more than the mere proportioning of parts, calculation of stresses, etc., and his technical application must be well rounded out with field experience. As a result of careful observation and field experience, certain changes have been made in the mechanical design of vertical waterwheel generators, and it is the purpose of this article to outline briefly some of the most important improvements made during recent years resulting from combined manufacturer's and operator's experiences.

One of the first noteworthy changes was the substitution of cast steel for cast iron in the load-carrying upper bracket. Several considerations made this change advisable. Cast steel, with its greater strength and smaller deflection, permitted the use of less bulk or weight to meet a given condition. The constantly increasing physical dimensions of units has hastened the conversion from cast iron to cast steel and, having proved itself on the larger units, it has found ready acceptance on the smaller machines. Along with this change came the logical step of eliminating, wherever possible, the heavy design of the cast iron lower bracket. The lower bracket carries no load, and is, therefore, designed to carry the lower guide bearing only and have sufficient strength to resist side thrust due to unbalance, either dynamic, magnetic or both. Structural steel has proved to be an exceedingly desirable substitute for cast iron in the lower bracket, especially on the large-diameter machines. It not only permits a saving in cost but also facilitates erection and allows for greater accessibility.

Along with the tendency towards lighter upper and lower brackets, came a modification of the means of supporting the frame on the foundation. Practically all generators installed in the past rested upon heavy continuous cast-iron base rings embedded in the concrete foundation. The more modern machines have short individual soleplates, sufficient in area and strength to carry the load without excessive pressure concentration upon the foundation. This modification in method of support came about logically inasmuch as considerable saving in cost and weight was obtained without any sacrifice in design. Proper leveling and lining-up by means of shims, of course, is required; but lining-up and leveling by means of shims was necessary even with heavy continuous base ring since this base ring support did not possess sufficient rigidity of its own.

After having given the larger parts, such as brackets, frame and frame support, careful thought and consideration, the details then received attention. Among the first of the details to be changed were the cover plates between the upper guide bracket arms. The expanded metal cover plates formerly supplied were too flexible when supporting the weight of an operator. Solid and rigid plate steel covers between the upper bracket arms are now furnished.

The next improvement, namely that of the oiling system, was dictated by field experience. Instead of

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individual risers of oil feed pipes to the thrust and guide bearings, it was found preferable to use a single main riser feed pipe, discharging into a container located at the highest point and provided with an overflow return to the bottom oil pan in which the pump is located. Individual feed pipes descend from the common container, and the flow of oil, being that of gravity, cannot only be regulated by individual needle adjusting valves, but sight feed gages readily permit observation of proper oil flow in each feed line. Each bearing is furthermore equipped with its own overflow which, in turn, connects with the bottom oil pan. This system avoids the danger of building up high pressure in the line, a condition which may at times burst the sight feed glasses.

With the oiling system under consideration, the feature of excluding air was next given attention, for oil, while in agitation, is subject to foaming. If absorption of air is permitted unrestrictedly, the result will be carbonization of the lubricant, furthered by the accompanying higher temperatures. It is for this reason that the air seal feature of the thrust bearing was inaugurated. This feature is accomplished either in the form of a packing seal by means of fiber shoes bearing against the smooth surface of the thrust collar shoulder and held against it by means of springs, or else, by a liquid seal, in the form of a small rotating chamber, containing a limited amount of oil trapped so as to prevent air from passing into the thrust bearing pot.

Changes in the oiling system naturally carried with them the improvements in method of sealing bearings, so as to prevent oil leakage. Careful studies and experiments along these lines showed that oil leakage is primarily due to oil vapors, foaming, and suction set up by the rotating element, which is usually equipped with fans or blowers for ventilation. This resulted in the development of the "air bypass," which consists mainly of a rotating and a stationary chamber. The former acts as a trap for oil vapors and foam, and the latter is connected by means of an ample-sized pipe with a neutral pressure air zone outside of the machine, balancing the air pressure and neutralizing any suction action set up in the stationary chamber. Both of these chambers surround the shaft and have a very close running fit to it so as to minimize suction and escape of vapor or foam.

Another new feature sometimes applied on large machines is that of installing indicators for measuring the amount of oil and proper information having been furnished the operator as to the amount of oil and water required, a check is thus established on the proper functioning of the entire system.

Insuring Against Shut-Down of the Oil Pump

Closely connected with the oiling system itself is the oil pump located in the bottom pan. Any failure of this pump or of the gears driving it may result in serious consequences. Careful study of this detail led to the adoption of coarser pitches for the pump gears, not so much on account of additional strength, but on account of the larger permissible variation in center distance. The running clearance in the guide bearing and the sometimes existing dynamic unbalance of the waterwheel may cause the shaft to crowd to one side. In the case of fine pitch pump gears, this may cause breaking out of the gear teeth, with the obvious result of putting the pump drive out of commission. In order to permit easier adjusting and assembling of this drive, the oil pan was split horizontally in such a manner that the pump and gears could readily be mounted and checked for proper running clearance in guide bearing, after which the lower parts of the oil pan could be bolted into place, fully enclosing pump and gears.

Formerly, the pump driving gear mounted on shaft was a combination gear and oil thrower, made in halves. Since the fit on shaft and at the split has to be oil tight, scraping at both these places was necessary. This is a very difficult hand-fitting operation, which at times affected the tooth spacing at the split and resulted in breaking of these teeth. It was therefore decided to separate these two items but still make the oil thrower in halves, inserting a $\frac{1}{16}$-in. Velumoid packing gasket at the split to insure oil tightness and facilitate fitting. The pump driving gear, also made in halves, is then clamped on the shaft and no further scraping is required. This leaves the tooth spacing in accordance with the original machining of the teeth.

The guide bearings themselves had to submit to the same close scrutiny as was employed throughout. Oil grooves were changed so as to provide an easier forming of oil film; no sharp, or even slightly rounded edges were permitted, and the grooves were provided with both sides beveled off gradually, so as to form a thin wedge-shaped entrance space from the groove proper. This feature has greatly aided in the reduction of bearing temperatures. For the same reason, the top end of the oil grooves was flared out, so as to be funnel-shaped, and to permit a maximum amount of oil to enter.

The bearing shells, instead of having all cast anchor holes for holding the babbit in place, were provided with machined annular and cast axial grooves, at frequent spacing, to prevent babbit from becoming loose; temperature, and different coefficients of expansion between cast iron and babbit, will easily result in loose babbit, unless these additional precautions are taken.

On the rotating element, some changes as found necessary by actual experience, were made. On some machines in service, it was noted that the field coils were no longer clamped tightly and when the machine was slowing down and coming to rest, field coils would slide back and forth on the poles at each revolution. This was caused by a slight shrinking of the insulation after the machine had been in service for some time. In order to overcome this, a wedge adjustment was provided under the coils, which permits taking up the slight shrinkage of the insulation.

With this change, the coil supports also underwent a modification. Malleable iron was found to be inferior at times, a feature rather difficult to control. Again, higher speeds made it desirable to have recourse to a more reliable and stronger material, and as a result, fabricated steel coil supports were substituted, giving the desired insurance factor.

The foregoing furnishes an outline of progress made, and while the results are extremely gratifying, the field is probably not yet exhausted. New conditions will come up with the larger and larger units, making it necessary to keep step with future developments.

News-Comment on Power Legislation

BESIDES MUSCLE SHOALS, THERE ARE MANY OTHER IMPORTANT THINGS UP FOR CONSIDERATION IN WASHINGTON. BY WINGROVE BATHON

POWER matters will engage a large share of the attention of the committees of Congress and various executives in the Government departments during the winter season now beginning at Washington. Various pieces of legislation are to come up, some of it in bills coming over from the last session of Congress while new bills are now being talked about in advance. Among the executive departments, the Federal Power Commission is faced with a number of important executive decisions, soon to be made. Another interesting group of items of news and comment will come later on, when the annual budget of the Government is presented to Congress, because this will contain projected appropriations for many proposed new Government plants as well as money for replacements and maintenance.

Muscle Shoals still holds the center of the stage, as it has for 4 or 5 yr. in Washington in power matters, largely because in that subject there are many questions for and against Government ownership and operation and involved therein is necessarily a great precedent vital to the power industry. It happens, too, now, that the subject of Muscle Shoals and Boulder Canyon Dam are being more and more "tied in" together.

MANY THINGS UP FOR DISCUSSION IN WASHINGTON OF INTEREST TO POWER INDUSTRY

But Muscle Shoals is by no means the only important thing about to come on the Washington stage, from the point of view of the power industry. This correspondent this winter will endeavor to follow the development of thought and procedure in connection with the proposed Boulder Canyon Dam and the Colorado River improvement; the report of the Federal Trade Commission investigation of the General Electric Co., ordered by the Senate which is now in the printer's hands and about to be made public; the possibilities of action by the Federal Government in regard to the proposed $500,000,000 hydroelectric developments along the St. Lawrence River; the physical interconnection now taking place of many power companies from Kentucky to Florida and from Arkansas to the Virginia border as shown in applications to the Federal Power Commission for the building of transmission lines and to develop power sites and in other ways; the applications for preliminary permits to develop eleven dam sites on the Tennessee River above Chattanooga, its tributaries, the Clinch and Powell Rivers, now presumably about to be acted upon by the Federal Power Commission; developments in the Senate and House committees as well as before the Interstate Commerce Commission on proposed bus transportation legislation, which would vitally effect the street railway companies in the power industry; the proposed investigation before the Senate Judiciary Committee of the bread-making and allied industries which have been the subject of attack because of security holding companies similar to some of the legal fabric and structure in the power industry; the fight over the Conowingo project in Maryland and Pennsylvania; and many other subjects of interest to power executives.

For many years Senator George W. Norris, of Nebraska, has been chairman of the Senate Committee on Agriculture and Forestry. It was due to his high sense of public duty that the so-called Ford "offer" for Muscle Shoals was defeated. Rather, it should be said, upon his shoulders rested the responsibility for the leadership in that fight in the Senate. Not sufficient credit has ever been given Senator Norris for his stand in defeating the Ford proposal. In that fight, many persons paid attention only to the fact that Senator Norris is a Government-ownership-and-operation advocate, whereas that is merely a small part of the story. Senator Norris believes in the development and wide distribution of power, in storage dams and in physical connections and interconnections all over the country. In that respect, he believes in and works for the same ideas as the electrical power industry. But he believes that the Government ought to run the power business. Fortunately, we do not all think alike. Life would be very dull if we did. Senator Norris is now leaving the agricultural committee of the Senate, to become chairman of the Senate Judiciary Committee, which will have charge of the investigation in regard to bread, which may reach into questions in regard to all holding companies and thus affect the power industry.

SENATOR MCNARY OPPOSED TO GOVERNMENT OWNERSHIP

On the agricultural committee Senator Norris is succeeded as chairman by Senator Charles L. McNary, of Oregon, who believes in many of the things Senator Norris believes in but who is utterly opposed to the Government engaging in the power business. Able, intelligent and honest, he stood at the right hand of Senator Norris all through the fight on the Ford plan for Muscle Shoals and Senator McNary is well fitted to become chairman of the committee. As the new leader of the committee, his views are important.

Speaking to the writer, for Power Plant Engineering, Senator McNary said that he had always supported government operation of the Muscle Shoals plant for the production of nitrates in time of war and fertilizers in time of peace and expected to continue to do so. He holds that the plant was built upon the site of a great natural national power resource, with the intention of taking whatever advantage there may be of this natural power resource for the benefit of the people, first, for national defense and, second, for fertilizers for peacetime uses. Muscle Shoals and the Colorado River project stand out in his mind as on a par. Both problems have national aspects, he thinks, the first, Muscle Shoals, in its relation to national defense and the second, the Colorado River and the Boulder Canyon Dam project, in its relation to flood control. The production and disposition of power at both of these projects, to his mind, are side issues.

Senator McNary believes that the Government should operate the nitrate plants or build new ones or additions thereto at Muscle Shoals for the production of fertilizers. That is the quickest way, he thinks, to take Muscle Shoals out of politics, for he believes it will be ascertained within a year or two whether the Government can do so properly and satisfactorily. If the Gov-

ernment does not do so, he believes there will be a howl from the farmers which will bring about a readjustment automatically.

He is not in favor, however, of the Government going into the power business. He believes that the surplus energy developed at Muscle Shoals should be sold or leased to private parties, giving the preference of rights of purchase first to municipalities which might do their own distributing and supply power to users at a low cost, rather than to private parties or corporations which would add a profit before the power reached the consumer. He was emphatic in expressing himself as against the Government going into the power business—"Not a bit of it," he said.

Senator McNary believes that, if President Coolidge, Secretary Hoover, and other leaders in the present administration can espouse, as they do, the cause of the Government participating in the building at Government expense of the Boulder Canyon Dam on the ground that flood control of the Colorado River is a national duty, these administration leaders could equally well espouse the cause of the Government operating Muscle Shoals for fertilizer manufacture as a national duty. Certainly, he said, he can take that position with good grace, because, if flood control is a national duty, cheaper fertilizer production is likewise equally a national duty and, in the case of Muscle Shoals, there is no question of the Government making a large new outlay of millions of dollars for the initial plants. He points out that the Government has already spent the money necessary for the millions of dollars of investment at Muscle Shoals and all that remains is to see whether the Government can operate it.

At the last session of Congress a joint committee of the House and Senate which had dealt with all of the proposed bidders for Muscle Shoals made a report, which is now on the calendars of both Houses awaiting action, accepting the offer made for Muscle Shoals by the following power companies: Tennessee Electric Power Co., Chattanooga, Tenn.; Memphis Power and Light Co., Memphis, Tenn.; Mississippi Power Co., Gulfport, Miss.; Mississippi Power and Light Co., Jackson, Miss.; Mississippi Delta Power and Light Co., Greenville, Miss.; Alabama Power Co., Birmingham, Ala.; Gulf Power Co., Pensacola, Fla.; Kentucky Utilities Co., Louisville, Ky.; Gulf Electric Co., Mobile, Ala.; Georgia Railway and Power Co., Atlanta, Ga.; Louisiana Power and Light Co., Monroe, La.; Arkansas Light and Power Co., Pine Bluff, Ark., and New Orleans Public Service, Inc., New Orleans, La.

Senator Deneen, of Illinois, is the chairman of the Joint Congressional Committee which negotiated a contract with the power companies, after deciding that all other offers by other bidders were inadequate and, under the contract now pending, awaiting approval by Congress, the power companies agreed to make fertilizer and to distribute all of the electrical energy not needed for fertilizer equitably in the surrounding states, as required by Congress. Senator Deneen is now preparing his speeches, in the hope that he will be able to get action on the report in the Senate shortly.

As time goes on, with still no action, the sophisticated Washington observer is almost at last tempted to join the chorus of a number of editorial writers throughout the country who are beginning to express the point of view that Congress is not capable of solving an economic problem such as Muscle Shoals because of the fact that politics invariably creep into the consideration. This year, some Senators and outstanding figures in the House of Representatives are themselves beginning to express that point of view, at least in private conversation. The bill leasing the plants to the group of power companies is about to come up with the outcome indefinite at this writing.

Tree Climbing Children and High Voltage Wires

IF A CHILD, CLIMBING INTO THE CHARGED WIRES OF A POWER LINE IS KILLED, CAN THE POWER COMPANY BE HELD RESPONSIBLE? BY LESLIE CHILDS

LIABILITY of power companies for injury to children, caused by the latter climbing into trees and thus coming into contact with high voltage wires, has been the subject of much litigation. But, since each case of this kind has necessarily been decided in the light of its particular facts, the subject cannot be covered by a hard and fast rule.

This much, however, may be said. The maintenance of a power line carries with it the duty to exercise a high degree of care, in respect to protecting children who by any chance may come in contact with such line. So much for the general rule. As an example of its application to the facts of a particular case, the recent Oregon case of Cooper vs. North Coast Power Co., 244 Pac. 665, may be reviewed with interest and profit by power line executives in general.

FACTS IN THE CASE

In this case the defendant, the North Coast Power Co., maintained a power line between the towns of Goble and Rainier, Ore. The line crossed the "Newsome tract" a body of 5 or 6 acres of partially wooded land within the limits of the town of Rainier. This tract of land, because of its convenient location and beauty, was frequently used as a picnic ground by the general public.

In crossing this tract, the defendant's power line passed over a yew tree which had attained the height of 50 ft. The defendant topped this tree to a stump of 16 ft. and 4 in., after which there still remained many wide spreading branches. Near the tree and partially covered by its branches there was an uninhabited shack.

On the occasion out of which this action grew, Walter Cooper, a 12-yr.-old boy, in company with about 25 other boys and girls, all pupils of the Rainier public school, together with their teacher, went upon the "Newsome tract" for the purpose of picnicking. While upon the grounds, Walter, with other boys of his age, climbed into the yew tree. Walter in some manner came in contact with the defendant's line carrying 6600 v., and was instantly killed. The instant action was thereafter brought against the defendant power company and one Ringle, its representative, to recover damages for the boy's death.

In defense to this action the power company, among other things, took the position that the boy had been guilty of such contributory negligence as would justify the trial court in directing a verdict in its favor. The

trial court, however, denied a motion of this kind and submitted the case to the jury. The latter returned a verdict in the sum of $4000 against the power company. From judgment on this an appeal was taken to the higher court and here in reviewing the record, in respect to it showing contributory negligence on the part of the boy, the court, in part, said:

THE RECORD REVIEWED

"There is no evidence, direct or circumstantial, tending to show that Walter ever was warned or knew of the danger of the situation, or that he ever knew that the wires were uninsulated or were located in the vicinity of the tree. Nor is there any evidence tending to show that he ever touched the wires with his hands or purposely came in contact with the wires. * * *"

Then turning to the conclusions drawn from the record as to knowledge the power company had, or should have had, of the possible danger to children in the way the wires passed over the yew tree, the court, among other things, said:

"The testimony further shows that the defendant Ringle, in behalf of the company, has inspected the lines about twice every two months since its construction. A necessary conclusion from the record is that there is some testimony that the defendants knew, or ought to have known, that there was some danger in the attraction to children arising out of the construction and maintenance of its power line over the yew tree stump on the Newsome premises, and should have taken some precaution for their protection. * * *"

Following the foregoing review of the record, the court in stating the general rule of duty resting on the power company to guard its lines, in part, said:

"It was the duty of the defendants in the construction and maintenance of the power line to provide such protection as would guard against any contingency that was reasonably to be anticipated. * * *"

Then, in amplifying this rule, the court quoted from Temple vs. McComb City Electric Light & Power Co., 89 Miss. 1, in part, as follows:

"As to the duty to guard against danger to children in placing electric wires, no rule can be enunciated that would be accepted by all courts. * * * It would seem, however, that reason and humanity, alike, support the rule laid down * * * that those dealing with such an extremely dangerous agency as electricity should, in stringing their wires in places where it is reasonably probable that children will go, be charged 'with the very highest degree of skill and care' to protect the children from injury while in the vicinity of such places, even though they may be trespassers."

Following the foregoing statements of the general rule, the court, after reviewing many authorities, concluded its opinion in the following language:

WHAT THE COURT DECIDED

"If there was some general probability of danger, the company has the duty of anticipating it and it is not necessary that it should know and appreciate the precise way an accident might occur because of danger. * * *

"We have said that the alleged negligence of the defendants presented a jury question. We also hold that the court properly denied the motion upon defendants' contention that the boy was guilty of contributory negligence. * * * There being no error in the court's instructions, this case must be affirmed. * * *"

The foregoing decision constitutes an apt illustration of the importance of the exercise of extreme care, in the maintenance and inspection of power lines, in respect to points where children may by any chance be attracted within a danger zone. Truly the case, when read with its facts and conclusion, is one that power line executives may with profit have in mind when instructions, relative to inspections, are being issued to those charged with the actual work of seeing that a line is free from all possibility of danger to children.

Tendencies in Power Plant Design

CONSIDERATION OF TENDENCIES IN FUELS AND OF DESIGN, ARRANGEMENT AND OPERATION OF POWER PLANT UNITS

"NOBODY, I believe," said Francis Hodgkinson* in his address before the joint meeting of the Western Society of Engineers and the Chicago section of the A.I.E.E., on November 22, "will dispute the statement that the most important factor of national wealth is an abundance of cheap energy. It has come to be the thing by which civilization is measured."

Referring to some published statements, he said: "These writers predict that in the future with further increased per capita consumption of energy, yet fewer hours of labor will suffice for the needs of the world. This abundance of cheap energy must be produced with the greatest possible conservation of that great national resource—fuel—which some writers have said, in deprecation of our modern civilization, we are burning up like drunken sailors.

"There are essentially two methods of generating electric energy: One by means of the consumption of fuel (coal, oil, or gas); the other by means of the hydro-electric plant; the latter utilizing our many rivers. It seems unfortunate that hydro-electric developments cannot be carried to a greater extent. Of course, the reason is the high cost of development and, consequently, high fixed charges. I do not doubt that a steam plant in the neighborhood of Niagara Falls would, if given a fair load factor, produce energy more cheaply than can Niagara Falls. This is an unfortunate condition, for the water running down our rivers, except for irrigation and domestic purposes, renders us no service. That energy, which is being continuously furnished by the sun, is definitely lost if not used for power production.

"A comparison between the hydro and the steam station, of the masses of operating fluids, is somewhat startling. The consumption of one pound of good coal in a modern plant will give the same energy as 10 t. of water falling 100 ft. This comparison enables one to visualize the enormous comparative volumes involved

*Consulting Mechanical Engineer, Westinghouse Electric and Mfg. Co.

in the hydro project and the reason its fixed charges are so high.

After reviewing the progress made during the last decade Mr. Hodgkinson said: "It was pointed out in the 1925 report of the Power Generation Committee of the American Institute of Electrical Engineers that between 1922 and 1925, as each new power station went into operation, the over-all heat consumption dropped from about 19,500 B.t.u. to 14,500 B.t.u. per kw-hr., a gain of approximately 25 per cent.

Available Fuels

Speaking of available fuels, he said: "It would seem that we should not much longer burn raw fuel under a boiler, when by distillation processes, after deducting the heat required for distillation, some 75 per cent of the heat value in the raw fuel (bituminous coal of 13,500 B.t.u. per lb.) is available for energy production in the form of coke, gas and light oils. In addition to this, there become available the ammonia compounds and the hundreds of coal tar products. "Why should not the public utility company of the future be a fuel combusting company with power generation an important incident to its processes?"

Use of steam in pressure stages by combining high and low-pressure boilers through the intermediate agency of a steam turbine was then considered. The high-pressure boiler serving power demands; the low-pressure boiler, industrial process demands. "In this instance, and with the heat charged to power and the industrial process, respectively, in the proportion of the heat absorbed, the industrial process would be charged 86 per cent and power production 14 per cent of the total boiler house costs, to each of which, of course, must be added the respective fixed charges. In a good-sized installation, the turbine water rate would approximate 28 lb. per kw-hr. and power would be generated at a rate of 3900 B.t.u. per kw-hr., neglecting boiler house losses and radiation.

"Just such an installation consisting of two turbines is being made at the present time. Each will expand 150,000 lb. of steam per hour from 800-lb. boilers to an exhaust pressure of 165-lb. gage, generating 4740 kw.

High Steam Pressure

"Concerning high steam pressures: Little trouble has been experienced and but little is anticipated by the steam turbine designer, with the pressures thus far used. There are now three large installations in this country employing 600-lb. pressures and more about to go into service. Two plants have been in successful operation with 1200 lb. pressure exhausting into the main steam line of a steam plant, delivering steam to lower-pressure turbines at about 300 lb. pressure. Pressures of 3200 lb. have been proposed but there have as yet been no practical applications.

"Engineers occupied in the design of turbines foresee no insurmountable difficulties in the design, even for the highest pressures thus far contemplated. They would, however, be more concerned in designs for materially higher temperatures than those in use today."

After discussing the effect of high temperature, especially of difference of temperature, on the strength of parts, Mr. Hodgkinson said: "Fortunately, much higher economies from the theoretical standpoint, are to be secured by increasing the pressure rather than the superheat, which is true in practice, at least in the case of large turbines.

"Generally speaking, from the turbine designer's standpoint, the application of extra high steam pressures to large turbines such as employed by public utility companies is an easier problem than their application to the smaller capacity units used by industrial companies. Usually, in cases of large power units for central stations, separate high-pressure turbine elements will be employed, expanding from the extra high pressure desired to a convenient, relatively high exhaust pressure, perhaps one selected that is the best pressure at which to apply reheating, after which it is employed in other turbine units wherein it is expanded to the condenser pressure. In such instances, a capacity of high pressure element sometimes may be selected which will more or less best suit the turbine design, perhaps a single high-pressure unit serving several low-pressure units.

"The higher the pressure the greater the deposition of moisture, some proportion of the latent heat of steam being given up during the near adiabatic expansion of steam. Some installations employing high pressures have been made in which reheating has been employed; that is, the partially expanded steam has been removed from the steam path and re-superheated, generally by a reheat boiler, and returned to the steam path. This may be performed a number of times if desired and a completely dry cycle obtained."

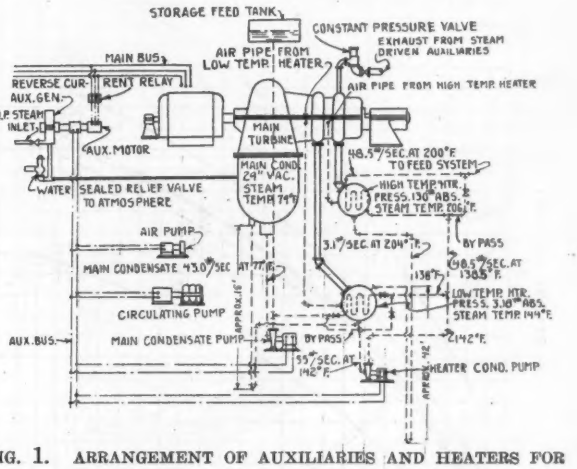


FIG. 1. ARRANGEMENT OF AUXILIARIES AND HEATERS FOR 20,000-KW. WESTINGHOUSE TURBINE

Main steam, 43.0 lb. per sec. at 10.2 lb. per kw-hr.	15175 kw.
H. T. heater steam, 3.1 lb. per sec. at 17.5 lb. per kw-hr.	629 kw.
L. T. heater steam, 2.4 lb. per sec. at 13.1 lb. per kw-hr.	661 kw.
Total kw. delivered at gen. terminals	16465 kw.
Total auxiliary load	393 kw.
Total load delivered to switchboard	16072 kw.

Conditions:—
The steam flow and temperature figures given in this diagram are for a 20,000-kw. turbine (the 328 c. w.) running at 16,000 kw., the point of maximum efficiency.
Steam pressure, 275-lb. at throttle.
200 deg. F. superheat.
29-in. vacuum at exhaust.
B.t.u. rate, including auxiliaries, 12,490 B.t.u. per kw-hr.
When the high temperature heater condensate is admitted to the low temperature heater, 0.2 lb. per sec. evaporates.

Speaking of the possibility of more than one stage of reheat, Mr. Hodgkinson said: "The gain due to reheating is offset by the increased cost of the reheating apparatus with its ponderous piping, added complexity to the turbine and more complicated regulating apparatus to preclude overspeeding because of the steam enclosed in the reheater and piping in the event of the turbine being relieved of load, so it is expected that reheating will not be employed to a great extent except in cases of high fuel cost."

Selection of Auxiliaries

One of the features that has contributed much to later improvements in steam power economies has been the selection of auxiliaries. In the earliest large stations, the auxiliaries were driven by electric motors. Lack of reliability at the time, reduced the effective-

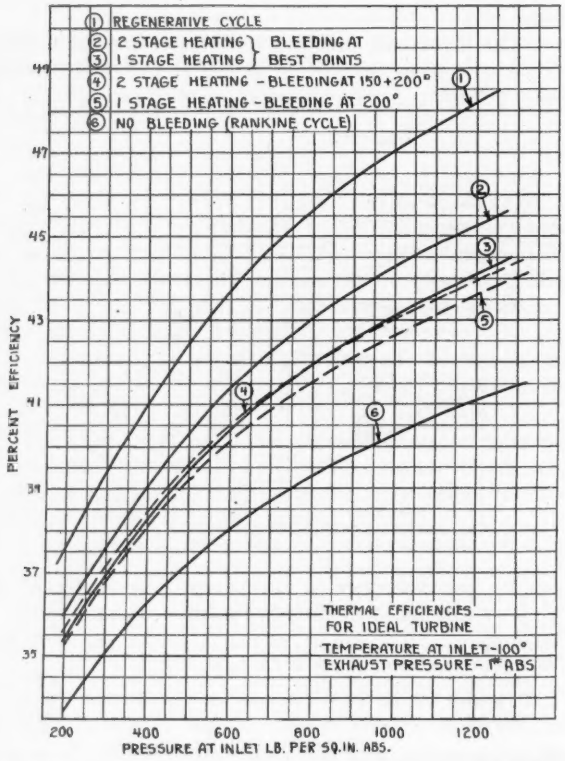


FIG. 2. RELATION BETWEEN THERMAL EFFICIENCIES AND INLET PRESSURES

ness of this method. This practice was quickly changed therefore to that of driving the auxiliaries by steam power, the exhaust from which was employed for heating feed water.

"It was generally customary to endeavor to proportion the steam-driven auxiliaries so that 200-deg. feed water, about the highest temperature possible with an open-type feed-water heater, would be secured with about three-quarter load on the main unit. This was not entirely satisfactory, because it meant that with loads on the main unit less than this, there was waste of exhaust steam to the atmosphere, and with higher loads, lower feed-water temperatures, at a time when hot feed was most desired. This objection was overcome years ago by the development of various valves, which later came to be known as 'constant pressure valves', the simplest form of which delivered any excess amount of auxiliary exhaust steam to a low-pressure stage of the turbine. Other more complicated valves were developed which would, in addition, bleed steam from the turbine at any time there was a deficiency of exhaust steam for feed-water heating, provided the load on the main unit was great enough. These valves practically maintained a constant, predetermined pressure in the feed heating system.

"Another objection to steam-driven auxiliaries was the multiplicity of steam and exhaust pipes, drips and drains, which added considerable mess, heat and discomfort in the basement of the power plant where such auxiliaries were usually installed."

Maintenance of Heat Balance

The house turbine which furnishes energy for all essential auxiliaries was then developed. The condenser of this turbine employed condensate from the main units for circulating water, heating the feed to about 200 deg., water economizers in connection with the boiler, being used for further heating. "There were instances in which the auxiliary system was tied to the main bus bar system by means of a motor generator set, when, by distant control of the house turbine governor, any desired heat balance could be maintained, any portion of the energy being supplied either from the main bus or the house turbine; the house turbine, however, being capable of supplying all the energy in the event of failure of electric supply from the bus bars.

"The same result was accomplished, at least in part, in a number of instances, by providing a dual drive for some one or other of the auxiliaries such as the circulating pump, this being driven both by a turbine and a motor, the latter receiving its energy from the main bus. The steam flow through the turbine was established to meet the demands of the feed-water heating system and was made sometimes manually and sometimes automatically responsive to the steam pressure in the feed heating system. All these systems heated the feed in one stage only."

Multi-stage feed-water heating by bleeding steam from different stages of the prime mover was then brought out. "This process is undoubtedly the most efficient of any, because of the steam expanding through the most efficient engine available in its descent to the pressure incidental to the respective feed-water heaters. If, however, the auxiliaries are operated by electric motors, taking thir energy from the main bus bars, the question of continuity of operation of the auxiliaries in the event of electrical disturbance is involved and, in this respect, the general scheme is no better than the practice of the earliest methods described.

"This has led to the devising of various means to insure continuity of operation of auxiliaries. One of these is illustrated in Fig. 1, and is known as a floating house turbine system, in which the energy for the auxiliaries is normally taken from the main bus bar through a motor generator set or synchronous machine. The motor generator set has the advantage of complete electrical separation. Coupled to this is a simple but rugged steam turbine with reliable governor and air-proof, water-sealed glands. With the turbine giving energy, it exhausts to the atmosphere through a free

exhaust valve, but there is a small pipe connecting the exhaust of this turbine to the main condenser. The governor on the steam turbine is adjusted to control the speed at about 5 per cent below normal frequency. Under normal operation, therefore, the turbine governor-controlled valve is closed, and the turbine is running idly in a high vacuum, the energy for operating the auxiliaries being taken from the main bus bars. Vacuum is maintained in the turbine casing by the small pipe connecting its exhaust with the main condenser, in this way reducing the windage of the idly-running turbine to a negligible quantity.

"In the event of an interruption, the auxiliary system frequency will drop 5 per cent, when the floating house turbine governor will admit steam supplying all the energy required, the exhaust steam escaping to the atmosphere except for the amount which will pass through the small pipe to the condenser.

Application of Regenerative Principle

"For obvious reasons, there must be steam-driven boiler feeding equipment available, even though motor-driven pumps be employed in normal operation. The regenerative principle of stage feed-water heating may be carried out to any degree, heating feed, if desired, to within a few degrees of the temperature of the water in the boiler. It can be carried out in an indefinite number of stages with added efficiency, the practical limit being the justification of the cost of the heaters. With an infinite number of heaters, the steam cycle would correspond to that of Carnot. The cycle, however, actually would be an infinite series of portions of the Rankine cycle. Generally speaking, four stages of heating for initial pressures of 400 lb., or thereabouts, are the most that can be justified. The higher the pressure, the greater the gain due to this system of stage feed-water heating as is shown in Fig. 2.

"This system, if employed for carrying out all the feed heating, removes the water economizer from consideration with its value as a means of usefully depressing the gases leaving the boiler proper to a reasonable degree above the temperature of the atmosphere. Fortunately, the development of preheating the air to the furnace becomes a means of usefully absorbing the desired degree of heat from the flue gases. It is reported that at the plant of the Philadelphia Electric Co. at Chester, the boilers have operated without difficulty for long periods with 300-per cent rating, admitting air to the stokers at 550 deg.

Change Needed in Performance Statement

"This method of operating turbines on the regenerative principle, bleeding steam from them for heating feed, brings about a need for a different method for expressing the economical performance of the turbine. It has been customary in the past to express the performance of a turbine in pounds of steam per kw-hr. under prescribed conditions of load, pressure, temperature and vacuum, and it has been customary on several occasions where a turbine is designed to bleed, to make guarantees of steam consumption in pounds of steam per kw-hr. but with the turbine not bleeding."

This condition, however, may not exist when the turbine is in actual operation. The two conditions, however, require different proportioning of turbine elements.

"With this practice," Mr. Hodgkinson said, "there is naturally a tendency on the part of manufacturers to proportion the turbine so that the highest guarantees may be made and the highest test results attained under the specified test condition, regardless of the results to be secured under another condition, the actual operation of the plant. Steam turbine performances, therefore, are best expressed in terms of B.t.u. per kw-hr., the turbine being charged with the total B.t.u. in the steam at the throttle and credited with the B.t.u.

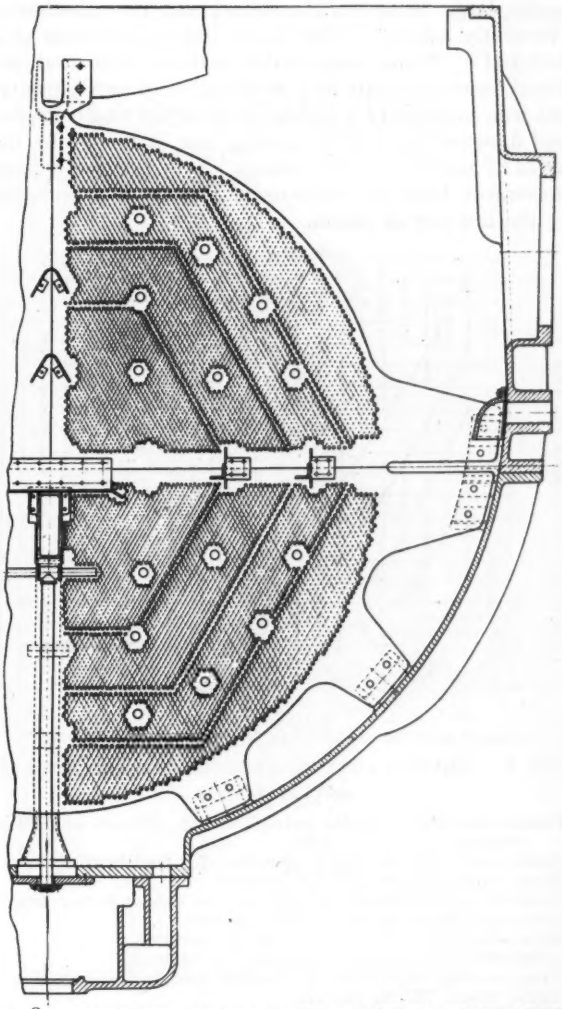


FIG. 3. CONDENSER DESIGN WHICH INCLUDES DEAERATION PROCESS

in the water leaving the hottest heater. Objection to this has been advanced on the ground that tests could not be carried out because of the difficulty of weighing water at some 300 deg. F. temperature, or more. This, however, may be readily accomplished by the temporary installation of a heat interchanger in the condensate line to cool the water sufficiently for weighing, the heat to the feed-water furnished by the feed-water heaters, of course, being lost during the period of the test."

Discussing the corrosive effect of dissolved oxygen in the water, Mr. Hodgkinson said this required the addition of the process of deaeration. For this reason, deaerators have come to be supplied in many impor-

tant installations. This, he believes to be entirely unnecessary if care is taken in the design of the condenser to secure some actual evaporation in the hotwell. "The Westinghouse Co.," he said, "has devised condensers which effect this and it does not hesitate to guarantee an oxygen content not to exceed 0.03 to 0.05 cc. per litre of condensate, 0.1 cc. per litre having been, in the past, generally considered as good practice.

Influence of Turbine Blade Design

"Nowadays we hear a great deal about extraordinarily large units being installed and the question is frequently asked: "What is the limit of capacity of a turbine?" While compounded turbines with multiple low-pressure elements may be installed of any capacity, the true capacity of a turbine for a given rotative speed and designed for a given leaving loss, is limited by the areas of the low-pressure blades, or, by what is a more convenient basis of comparison, the annulus occupied by the last row of blades.

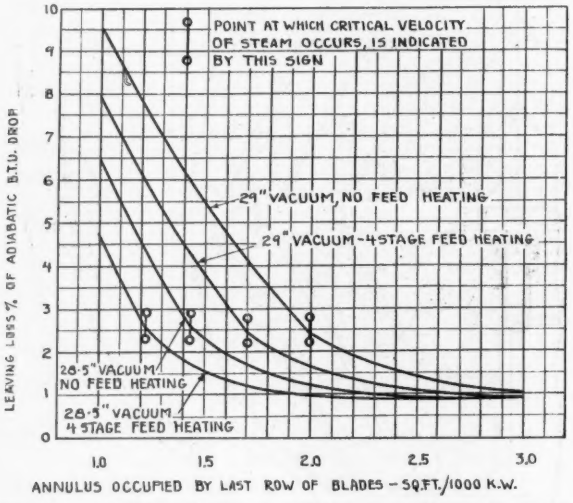


FIG. 4. LEAVING LOSS VS. ANNULUS OCCUPIED BY LAST ROW OF BLADES

Steam conditions, 375-lb. gage, 700 deg., 28.5-in. and 29-in. vacuum.
Steam rate, 9.31 for 29-in. vacuum. No feed heating.
Steam rate, 9.72 for 28.5-in. vacuum. No feed heating.
Rankine cycle efficiency ratio of turbine equals 80 per cent.
Generator efficiency equals 96.3 per cent.
Adiabatic B.t.u. drop, 476 for 29-in. vacuum.
Adiabatic B.t.u. drop, 456 for 28.5-in. vacuum.
Feed heating curves are for heating feed to 360 deg. F.
Blade speed, 762 ft. per sec.

"This area is dependent upon the physical dimensions of the disk or drum and by the height of the blades attached thereto. These, in turn, are limited by conditions of stress, which with progress, have been increased from time to time. Further, there have been improvements of design until 750 ft. per sec., mean blade speed, and 1000 ft. per sec. tip speed, have become not unusual practice.

"The height of a blade which may be attached to a disk or drum besides being limited by centrifugal stress, is also limited by considerations of the disparity of blade velocity between the tip and the root, which cannot be satisfied with one steam velocity and constant inlet and discharge angles. This further gives a disparity of circumferential pitch of the blades between the tip and the root. The practice of parallel section blading having a height of one-fifth the mean diameter has not been generally exceeded.

"Various means have been devised for securing greater low pressure blade areas, such as the following:

(a) The use of tapered and warped blades.

(b) Low-pressure elements constructed double-flow.

(c) Separate low-pressure elements running at lower rotative speeds than the high-pressure element.

(d) Multi-exhaust elements, as devised by Baumann.

"The quantity of steam which may pass through the last row of blades in the turbine, for practical purposes may be said to be not limited. The effect of increasing the flow is to increase the velocities in the last row, and hence, to increase the leaving loss, and therefore reduce efficiency. Inasmuch, however, as the total cost of a steam turbine is dependent upon the low-pressure blade areas, this matter of leaving loss, or congestion in the low-pressure blading, is a prominent factor in the design. It also assumes importance in determining the economical efficiency and cost of a turbine, for a given condition of load factor. These losses are shown in Fig. 4, plotted against sq. ft. of annulus per 1000 kw. capacity for both 28-in. and 29-in. vacuum and with and without bleeding for stage feed-water heating.

"What might be called the true capacity of a turbine to expand to a given back pressure, with some arbitrary leaving loss, is to be measured by the area of the last annulus. Increases in capacity by increasing this annulus, keeping the r.p.m. constant, may be secured at somewhere near the same cost per unit of capacity; however, when this increased annulus and hence capacity are secured by reducing the r.p.m., the cost increases enormously."

Advantages of Compounding Turbine Units

Mr. Hodgkinson then enumerated the advantages of cross compounding turbine elements as follows: "The simplification of design; no need of compromising the steam path for mechanical reasons; less temperature ranges within a single structure; simplification of each structure because of lesser size; a rotative speed selected for each element appropriate to the steam volume corresponding to the stage of expansion; greater rigidity of rotors because of their smaller size permitting the maintenance of finer clearances. By operating the low pressure element at a relatively low speed, any last row blade area can be secured and simple blade construction involving any degree of low stress desired may be employed.

"Because of the law of weights of similar turbines varying inversely as the cube of the speed, the tendency of modern design is properly to secure the greatest low pressure blade areas at a given speed. There is a tendency, therefore, to force designs to higher blade speeds, to install the biggest possible blades on a given disk or drum diameter, and to adopt some form or other of multiple low pressure elements, all consistent of course, with a proper apportionment of leaving loss.

"The cost of turbines whose capacities have been increased by increasing both high pressure and low pressure blade areas, increases at a ratio not exceeding unity of the increase of low pressure blade area, provided no great extreme of construction is adopted in

order to secure these increased areas. Thus, the maximum capacity turbine at a given speed should be the most profitable machine to builder and purchaser alike, and it would appear that for the central station there should be a limited number of standardized capacities for a given frequency, i. e., the maximum capacity that lends itself to design for each synchronous rotative speed.

NEED OF FURTHER STANDARDIZATION

"It would be of value if some form of standardization could be devised not only of capacities of prime movers such as I referred to previously, but to include a specification of quality of design worded in such way as to require high quality of design, material and manufacture without retarding new and inventional development. Our British friends seem to enjoy some advantage in this respect by means of what would be regarded in this country as a 'Monopoly in Restraint of Trade'. The price is fixed for a turbine of standard steam consumption, but increases with higher efficiencies. The capitalized value of the higher efficiency is equitably divided between the purchaser and the price of the turbine. Thus, competition between manufacturers takes the form of more thorough and complete design rather than cutting prices, and tends to engineering progress."

Shipping Board to Use Diesel Engines

FIRST INSTALLATION ON THE TAMPA MADE TRIAL TRIP ON NOV. 8. NOW IN TRANS-ATLANTIC FREIGHT SERVICE

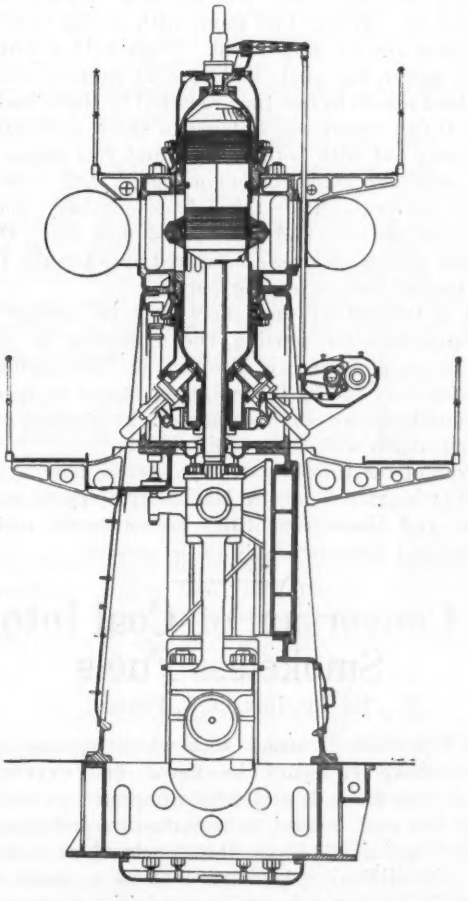
BY SPECIAL act, Congress authorized the Shipping Board to use $25,000,000 from its appropriations to install Diesel engines in vessels heretofore operated by steam. The first vessel equipped was the Tampa, which had a successful trial trip on Nov. 8 and then went to Charleston, S. C., to load with cotton for abroad. The Unicoi is now being equipped by the Newport News Ship Building & Dry Dock Co. and will soon be ready for sea.

Of distinctly American design and an American product, the engine used is a 4-cylinder, double-acting, 2-stroke cycle Diesel, built by the Worthington Pump & Machinery Corp. and designed by O. E. Jorgensen of that corporation. Section of the cylinder, valves and crankcase is shown in the illustration. Advantages claimed for the double-acting, 2-stroke cycle type are about three times the power of the single-acting, 4-stroke cycle type for the same piston displacement, smoother running, greater simplicity in design. A problem which had to be solved was proper cooling of the cylinders without sacrifice of strength or rigidity. Steel sheets are used for cylinders, the head and half cylinder being in one piece, thus avoiding cylinder head joints, and cooling water circulates from the center toward each end of the cylinder with independent flow regulation for the two ends. The design is, in effect, two opposed single-acting cylinders, with a distance piece between and the pistons mounted on one rod.

During the trial trip the Tampa was operated in regular commission, a full day run being scheduled. The Tampa is 416 ft. long over all with moulded beam of 54 ft., normal displacement of 13,010 t., net tonnage of 3703 and normal draft of 26 ft. 10¾ in. She carries 760 t. of fuel oil and makes normal speed of 11.5 knots an hour.

Engines have four cylinders, 28-in. diameter by 40-in. stroke at 95 r.p.m. and piston speed of 634 ft. a min. Two air starting tanks are provided holding 550 cu. ft. each at 400-lb. pressure. Maxim silencers are used on both main and auxiliary engines.

Three auxiliary engines are installed of air-injection type for driving generators. Other equipment is Nash Engineering Co. centrifugal pumps driven by General Electric Co. motors as follows: 750 g.p.m. for salt water cooling, 750 g.p.m. for general service, 500 g.p.m. for fresh water cooling, 200 g.p.m. for fire service, 300 g.p.m.



SECTION OF DOUBLE-ACTING, 4-CYLINDER WORTHINGTON DIESEL MARINE ENGINE

for engine room bilge, 70 g.p.m. for salt water and 70 g.p.m. for fresh water sanitary service. Two Kinney Mfg. Co. rotary plunger pumps of 150 g.p.m. are provided for lubricating oil and one of 250 g.p.m. for transfer of lubricating oil. To supply steam for heating and galley, a vertical boiler is used with 210-sq. ft. heating surface, run at 110-lb. gage and fired by a Sunbeam centrifugal oil burner. A 2-t. York ammonia compressor is driven by a Diehl motor at 235 r.p.m. Ten

Lidgerwood winches are driven by Westinghouse motors and controlled with Cutler-Hammer brakes, the same equipment being used on the windlass. All equipment was especially redesigned for the conditions on a Diesel-engined ship.

Costs of the change to Diesel engine power were: For installation, $210,000; for alterations, $125,000; for main engine and spares, $212,000; for new shafting and hub, $9000; for deck machinery and steering gear, $29,321; for engine room auxiliaries, engines, generators, pumps, coolers, switchboard, etc., $80,700; for repairs, $26,000; for equipment and outfitting, $25,000; for engineering, freight, traveling, extras, and trial trip, $23,000, a total of $740,521.

On the trial trip guests and observers were present representing shippers, equipment manufacturers, oil companies, shipbuilders, transportation companies, publications and the Shipping Board.

Tests were begun with readings at the dock at 8 a.m., followed by a run to Old Point with a stop to take on passengers and an anchor test. From 9:15 a 6-hr. run at full power was made and at 3:15 engines were put full speed astern to test time required to check headway. At 3:30 full ahead was ordered to check sternway and an anchor test with both anchors and full engine stop. Tests were also made for engine speed with main compressor cut out and air taken from auxiliary compressors; starting tests and a measured mile run. On the 9th runs were made over a measured mile and the Tampa then headed for its loading port.

It is understood that there may be further large appropriations for putting Diesel engines in government ships, and there is also talk in Washington that Congress may forbid the Shipping Board to spend its appropriations for engines built under foreign patents in competition with American builders.

Trial of the Unicoi is expected before long, at which the Worthington Pump & Machinery Corp. is inviting Senate and House committees on commerce, merchant marine and appropriations to be present.

Conversion of Coal Into Smokeless Fuels[1]

By Dr. Horace C. Porter[2]

TWO LINES of attack with which we may combat the smoke evil seem to be offered: first, to extend the use of good methods and good equipment in the burning of raw coal; second, to manufacture and burn more of the "smokeless" fuels—those fuels which cannot, except with difficulty, be burned so as to make smoke. Both of these methods entail some initial expense to the consumer, although he regains his outlay and often more, in the end. The first method has, up to the present, required the lesser outlay, therefore it has been used more than has the adoption of prepared smokeless fuels.

Psychology, as involved in this matter of initial expenditure and intangible returns, enters prominently into the question of smoke abatement. The fuel consumer hesitates when he is confronted with a higher bill for his year's supply of thermal units, or an additional outlay for improved plant, incurred chiefly to enable him to avoid smoke, dust and dirt. This hesitancy can be, and is being overcome among the larger consumers—the railroads, the utilities and the manufacturing industries—by the force of public opinion and by the realization of an ultimate profit to be derived from increase of operating efficiency and the benefits of clean, healthy atmosphere. The growth in centralization of power production, the increased use of gas in industry and the gradual replacement of the steam by the electric locomotive are already doing much to abate smoke.

To the small consumer, however, who finds it necessary to take account closely of initial outlay for fuel, the appeal for smoke abatement is quite generally in vain, if it means an initial burden of added cost. In order to go far with domestic smoke abatement among the masses, a smokeless fuel must be offered which carries only a small margin of cost, if any, above that of the raw fuels available.

The question arises, therefore: Can we hope to solve the smoke problem for these sections by offering them at reasonable cost, a smokeless fuel prepared from bituminous coal? Or must they depend chiefly on the use of improved burning equipment, central station power and greater care in operation of furnaces?

It has been estimated that the larger sources of smoke in the average urban community where soft coal is burned are the railroad locomotives and the small power plants serving individually the small factories, hotels, business blocks, etc. If a smokeless fuel suitable for the needs of these consumers could be offered them at a price little if any higher than that of coal and could be supplied continuously in sufficient quantity, it is probable it could be sold and good progress thus made in smoke abatement.

Dr. Porter then pointed out the necessity of bringing down the costs of conversion of coal into smokeless fuel to $1.00 per ton of coal or lower.

Three-Fold Problem Involved

The problem presented, therefore, is three-fold:

1. To lower the cost of conversion by engineering development of the processes to a point less than $1.00 per ton of coal, under existing commercial conditions.

2. To establish a sufficiently enhanced value in the semi-coke, ton for ton, as compared to the coal from which it is made, to enable a ton of coke to bring a return at least equal to the cost of the coal used in making it.

3. To discover commercial applications of the special tars and gases produced by these processes which will enhance their value above that of the now traded-in coal tar and gas.

As bearing upon improved efficiency and smokeless operation of boiler furnaces there is much interest being manifested now in the possible beneficiation of coal for boiler firing by pre-drying and partial carbonizing. In this way may be found a considerable impetus for low-temperature carbonization as applied to certain types of coal.

As Runge and others have pointed out, the net heat units available per pound under a boiler may be increased by 10 per cent or more through carbonization of a coal carrying, say, 6 per cent moisture. The stack

[1]Abstract of paper read November 17, 1926 at the International Conference on Bituminous Coal held in Pittsburgh at the Carnegie Institute of Technology.

[2]Consulting Chemical Engineer, Philadelphia, Pa.

losses in the items of moisture of the fuel, moisture from burning of hydrogen and heat of the dry chimney gases resulting from excess air supplied are materially reduced by the precarbonization treatment. This advantage may be found to lead to an important gain in burning, say, the Illinois type of coal.

Furthermore, it is reasonably to be expected that a boiler furnace may be pushed to higher capacities without reduction of efficiency or the making of smoke through the use of a free-burning dry and tarless fuel such as well-made semi-coke, than are possible with the corresponding raw coal. This advantage would lead thus to reduce cost of furnace and boiler equipment.

Direct-connected, continuously operated, pre-carbonizers on a boiler furnace would give the added advantages of sensible heat in the fuel and the minimizing of rehandling machinery or labor. But there are practical difficulties here arising from the necessity of rotating the boiler units in a plant so as to keep one or more out at all times for cleaning and repairs. Whether the carbonizers, if direct connected, could be shifted as required from one boiler furnace to another and thus maintain the continuous operation necessary for good results, constitutes an engineering problem well worthy of attention. At any rate, here is a field that presents possibilities of important advantages to be gained in low-temperature carbonization and enhancement thereby of the unit value of the fuel.

After discussing the by-product possibilities of the rich gas obtained by low temperature carbonization Dr. Porter added: It may be expected, therefore, that coal carbonization for the production of gas will extend itself rapidly and that methods for gas manufacture will more and more be used that produce at the same time practical smokeless solid fuels, capable of satisfying the conditions demanded by consumers. Whether high-temperature or low-temperature carbonizing methods will have the larger share in this development cannot be prophesied now. It is not reasonably to be voted, offhand, as has been done by some writers, that low-temperature carbonization is inherently wrong in principle and offers no economic prospects of success. It appears to be a question merely of reducing costs or of raising form-values in the products and these things are not beyond the bounds of possibility.

Conclusion and Summary

We believe the pre-treatment of coal for making smokeless fuel will go ahead along all three lines, high-temperature coke, low-temperature or "semi" coke and gas. Each will find a field to which it is peculiarly fitted and in which the consuming public will learn eventually to appreciate its virtues. Before prepared smokeless fuels, however, can have wide general application, their cost as related to that of coal will have to be lowered through simplification and improvement of processes and enhancement of by-product values.

New systems of pre-treatment of coal, such as low-temperature carbonization, will obtain a sure footing commercially only when they can show by lessened costs and better by-product values a good margin of profit to induce the investment of capital. Their best chance is in the field of the lower grade, higher oxygen coals of the midwest where a greater enhancement of value may be obtained, as between a low-priced raw coal and a high-grade conversion product.

Ice Troubles in Hydraulic Power Plants

Brunt of Battle Stood by Pioneer Developments Where Natural Conditions Are Most Advantageous to Ice Formation. Study and Intensive Development Have Done Much to Minimize Outage from this Source

COMPARATIVELY FEW hydro-electric stations are free from ice troubles of one kind or another during winter months. Ice jams, frazil ice, drift ice, frozen gates and reduced river flow combine to form a serious menace, sometimes making it necessary to shut down the plant.

As the river development progresses, these troubles often disappear. In rivers with no stream regulation and no power developments, all natural conditions favor an excessive frazil ice formation. During the first frost period of the season the swift moving whirling water temperatures will be lowered, will pass to the lakes and smoother pools as a cold surface stream and be subject to further cooling in the rapids and whirlpools below. Frazil ice forms readily when the water temperature drops to about 32.1 deg. F. and in local eddies the individual needles have a tendency to cling together forming large masses or they will cling to stones, sand, wood or iron forming similar lumps.

With clear weather and a cold wind, such formations appear at an air temperature considerably above that necessary on a cloudy day when a layer of heat insulating moisture saturated air on top of the water protects the surface. On bodies of still water, cold water remaining on top (water has a maximum density at 39.2 deg. F.) freezes forming a layer of ice to prevent further cooling. Below the water remains considerably above 32 deg. F. and frazil ice coming into such a body will disappear or rise to the surface and attach itself to the ice cover.

Frazil Ice Runs of Short Duration

Where conditions permit, a large forebay with a low velocity which will freeze over early is very effective in eliminating submerged ice formation. Fortunately, such ice runs last but a comparatively short time and except under unusual circumstances disappears when the stream freezes entirely over. Warm water tapped from the bottom of storage reservoirs on regulated streams is often sufficient to prevent frazil ice in the remainder of the stream and, as more power plants are put in service, the condition gradually disappears.

Where ice cannot be prevented from reaching the screens, various methods have been more or less successful under certain conditions. Hand or mechanical scrapers are sometimes effective if the ice run is not too heavy, although with modern installations, which will handle reasonably large pieces, the fine screens are often removed and a coarse board or plank rack substituted. Some danger, though, is involved to the turbines and

the larger pieces clinging to the racks may in time completely stop up the racks.

Electrically Heated Screens Prove Effective

Perhaps the most satisfactory method has been the heating of the rack bars. A fraction of a degree is sufficient to prevent sticking and the ice thus liberated may be raked to the surface and sluiced away. Racks made of hollow bars have been heated with steam; one plant thus equipped uses about 2.7 lb. of steam per hour per square foot of net screen area. Electrically heated screens are, however, more satisfactory and economical, the average of several installations showing a power consumption of about 0.3 kw. per sq. ft. of effective screen area or about 16 kw. per hundred sec. ft. of water flowing. Bars may be connected in series or parallel and three screens connected delta or Y. Due to welded connections, cables, etc., the actual resistance varies from about 5 to 8 times the theoretical value.

Such heating does not eliminate the trouble but it allows the ice to be raked to the surface and disposed of. Providing a heated shelter over the racks or other iron parts is often effective as the metal parts exposed to the air will absorb enough heat to keep the ice from sticking.

In extremely cold weather penstocks and pipe lines may become covered on the inside with an ice crust formed at the same time as frazil ice. With higher temperatures large pieces break off and will be carried down to the turbines where they may cause considerable damage. Covering with concrete or some heat insulating material is effective in overcoming this difficulty. Icing or sluices and discharge openings as well as freezing of gates and roller dams can be prevented by imbedding heat elements in the concrete or properly placed electrically heated steel bars. A 5-kw. heater will effectively keep a 40 by 20-ft. gate free from ice.

Cooling Air from Generators Can Be Utilized at Small Expense

Many plants are laid out to use heated air from the generators to prevent freezing at certain sections where it is particularly desirable to keep free from ice. Small structures over steel pipe lines, stoney gates, head gates and stanchions can thus be easily and effectively protected for the small expense of a fan or blower.

During the initial freeze period there is another equally important though less troublesome condition. Following the appearance of running ice in the stream the flow begins to decrease until a solid ice cover has formed, remains constant a short while until the source of supply has had time to fill up the additional storage area and then gradually recovers to somewhere between 60 and 85 per cent of the initial flow. Variations in flow are not the same for all rivers but depend upon the extent of the watershed, area of water surface, the flow at the beginning of the freeze, distance from headwater and power development of the stream.

By tapping the storage reservoirs to augment the natural stream flow, this condition can be remedied and the capacity of the station maintained. If, however, tapping of the storage reservoir is started after the layer of surface ice has formed, the water from storage must pass on top of the surface ice. Consequently, much of the water from storage is converted into ice and held until the spring breakup. Under such conditions the benefits of storage reservoirs for mountain streams practically disappears. To prevent this, tapping has to be started early before the frost commences and so continued that the flow in the river below be kept as uniform as possible.

Proper forebay design and condition does much to diminish ice troubles by forming a protective ice cover early in the season. Where velocities are high, log rafts properly anchored by steel cables to form a flexible unit will prove effective in favoring an early ice formation and also helpful in protecting the gates and dam from ice jams following the breakup in the spring. Anchored rigidly their effectiveness is not as great and they are soon broken up by the pressure of ice and water.

Aeroplanes Can Place Explosives Effectively in Large Jams

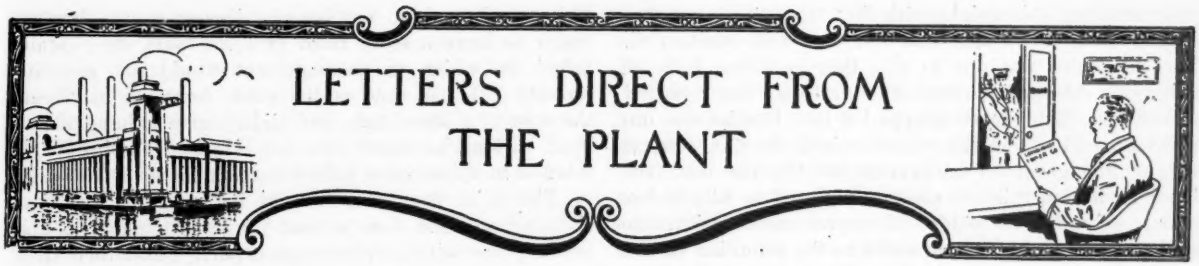
Dynamite carefully placed is effective in removing and breaking up ice jams or opening up stretches of river. Ammonia nitrate dynamite, equal in strength to 30 per cent nitro-glycerine dynamite, is exceedingly satisfactory for this use. It is slow burning, gives large gas volumes and does not freeze until 5 deg. below zero. Danger from unexploded charges is practically eliminated as a 3 by 8-in. stick will dissolve in water in an hour. Aeroplanes have been employed in large jams with considerable success. Bombs can be placed effectively in locations impossible to reach by other methods.

Ice pressure against dams must also be prevented. During periods of intense cold the surface of the ice gradually assumes the temperature of the air resulting in tensile stresses and finally cracks. These cracks become filled with water and freeze so that when the temperature of the ice is again near 32 deg. a tremendous pressure results.

Face of Dam Must Be Protected From Excessive Pressures

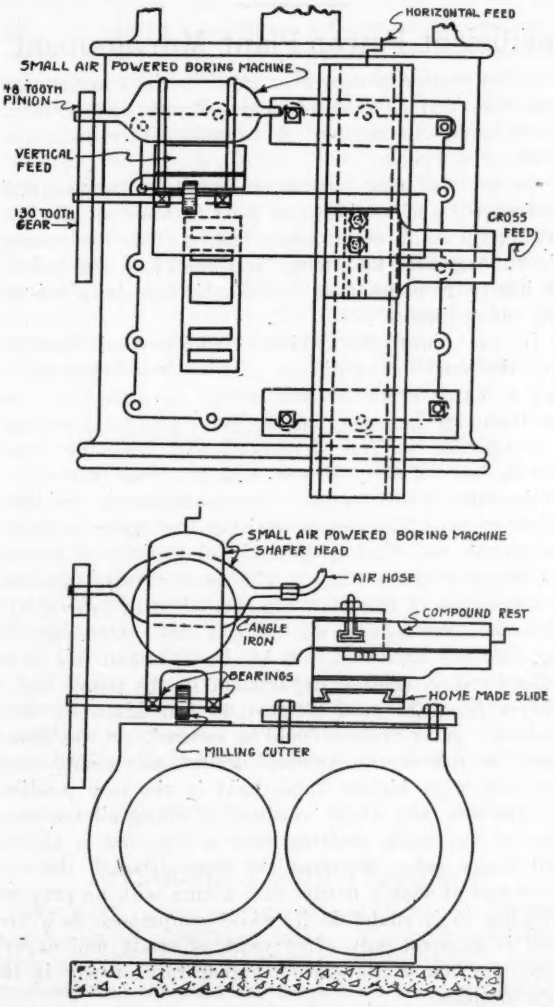
Probably pressures will not exceed 6 t. per linear foot for 30-in. ice and 9 t. per linear foot for 40-in. ice, extreme conditions found only in the most northern countries. It has been proposed to give the upstream side of the dam a steep slope so that the ice would slide up the incline, or to use some yielding material between the facing and supporting structures. Electric heating along the face of the dam has been used and blowing compressed air into the water in front of the dam has proved effective. The air causes a circulation of warm water from the bottom up along the face of the dam. Usually, however, a narrow strip is cut in front of the dam and maintained during the winter either open or filled in with brush covered with snow, straw or manure.

Developments should be planned with due regard to ice troubles likely to arise, climatic and geographical conditions. Properly-designed forebays with low velocities solve many of the troubles while deflecting dams and gathering tubes can be used where only a portion of the water is used for power. Floating ice is sluiced downstream by the excess water, while that required for power is taken from a lower strata. As streams are developed to their ultimate capacity, series of small rapids merged into well-regulated lakes and reservoir, each one toeing against the next higher one, ice troubles will practically disappear.



Refacing a Slide Valve Seat on a Pump Frame

FOR SOME time we have been having trouble with one of our 12-in. by 6-in. by 14-in. duplex feed pumps. The slide valve faces of the steam chests were badly worn and could not hold the steam. The construction of the pump is such that the steam cylinders and frame



PARTS OF AVAILABLE APPARATUS USED IN ORDER TO SIMPLIFY REPAIR JOB

are made in one casting. The work of dismantling this pump and setting it up in the shaper, together with reassembling it again would mean considerable time and expense, so we decided that instead of bringing the pump to the shop we would "bring the shop to the pump."

In our shop we had nothing larger for a planing job than a 24-in. shaper. We have a home-made slide which we use for other purposes, to which we attach the compound rest of one of our lathes. After the steam chest cover had been lifted off the pump, this slide was bolted to one of the seats, as shown in figure herewith. On this was fitted the compound rest. To the tool post slot was bolted, as shown, a piece of 4-in. by 4-in. by ⅝-in. angle iron, to which the sliding head of our shaper was fastened. On the front side of the head we bolted a small air-powered wood boring machine. This air machine was then fitted at the chuck end with a 48-tooth pinion. On the lower end of the shaper head two small bearings were provided for a 1-in. spindle. A 1-in. wide milling cutter, attached to this spindle, was placed between these bearings. This spindle was driven by a 130-tooth gear which meshed into the above-mentioned pinion. We thus had horizontal, cross and vertical feeds. A ¾-in. air hose, operating under 80 lb. per sq. in. pressure, furnished the power to the air machine.

After refacing the one seat, the whole rig was simply lifted off and turned around to the other side and the operation repeated.

Wabana, Newfoundland. J. B. PETRIE.

Repairing a Chain Grate Stoker

STOKERS in a plant where I was at one time employed were in sad need of repairs. In taking the matter up with the builders of the stokers, they estimated the cost of repair at $900 each, this to cover replacing the rollers with skids, removing worn bars and replacing them with new ones; also replacing some links that were burnt and worn. Since there were 12 stokers and the expense was great, the management refused to consider making the repairs.

Realizing the large saving that could be made in labor in pulling the drippings from under the stokers and the large amount of excess air due to holes in the furnace bed that could be avoided, also realizing that these drippings cause greater clinker formation, I began to consider how I could make improvements with a little expense. I bought some ¾ by 2-in. iron bars which I used for skids to be used over the old rollers. I also bought some ¼ by 2-in. iron from which I made U's to fit under the rollers and hold the bars in place. These bars were bolted in place with plow bolts. New bars were added where needed, the worn links were also replaced. Bearings were rebabbitted in one stoker at a cost of $150.

After starting this stoker, we weighed the drippings

and compared this weight with that from another stoker of the same size which had not yet been overhauled. The difference was one to six; that is where 1 lb. of drippings dropped through the grate of the repaired stoker, the other stoker dropped 6 lb. Besides the improvement in combustion which raised the CO_2 content in our flue gases on an average of 1½ per cent, the labor saving on this one stoker amounted to $3 per day and as we run 24 hr. a day, this represented considerable saving. When this was brought to the attention of the manager, he, after investigation, directed that all of the other stokers should be similarly fitted up as soon as possible.

Kansas City, Mo. J. F. STALEY.

The Value of a Spare Part Room

RECENTLY I had the extreme pleasure of visiting a boiler house containing 11 boilers burning a low-grade fuel requiring Dutch ovens. I say "pleasure," because I realize that few such boiler plants are in existence today. Their motto must have been, "Just lay it down." The boilers were splendidly arranged with ample stairs, and large platforms halfway up the boiler at the superheater headers and also at the top. Most boiler houses of smaller sizes would have considered themselves paradises with the convenience and ease of work afforded the operators. But the gang in this boiler house had no place to put anything. They had a multitude of spare parts, tubes, bearings, etc., but no place for them.

Tubes, the ends of which protruded over the sides of the boilers, loaded down the roofs of the Dutch ovens. Looking down from the top of the boilers, one would think that a bunch of tubes had been dropped down and left upon the arches.

Behind the boilers and on the platforms, the shorter tubes were piled, making it risky to walk because of the danger of having tubes roll over one's feet. Debris, consisting of broken brick, paper and scrap, that could not be cleaned away unless all the tubes were removed, was piled high between the tubes. Spare baffle and other brick were piled up on the side platforms between the boilers, but on the lower platforms the broken used baffle brick, removed during the last repair job, continued to lie. On the main floor, which was well concreted and roomy, spare stoker parts were stacked behind the boilers, almost interfering with the blowoff valves; while between the boilers lay all sorts of hooks, hoes and fire cleaning implements. Spare bearings and parts of fans and feed pumps were piled up alongside of these machines, while the work bench seemed to be a collecting place for miscellaneous fittings, bolts, pipe, tools and odds and ends. To do any work at the bench, one had to move the material to another part of the bench.

The class of men in the boiler house seemed to be high-grade. They understood their work. The foreman was on the job watching his steam continuously. No trouble was experienced in keeping up steam, as there was ample boiler capacity. But a glance at the machinery showed a lack of care; only half the flow meters operated, none of the triple draft gages had oil in them, and no interest at all was taken in the "unessential" items. I asked the boiler foreman the cause of such disorder. He shrugged his shoulders and wearily answered that they simply had no place to put things. The superintendent had become discouraged in his attempt to have a store room or spare part shed established, to which the management would not give its consent. He, as well as the other foremen, had been there only a short time and didn't give a hang about looks as long as steam was up. He had absolutely no interest in appearance, safety (except his own) or costs.

The point that was brought home to me was that the company had done a good job in putting up a fine boiler plant with ample steam capacity, and then they dropped it. Visitors would naturally place the blame for such conditions on the boiler men; whereas they had tried their utmost to do their part. It is too bad that, as a rule, the management and engineering departments put up the best steam-producing boilers that money can buy, but neglect the provision of necessary conveniences, such as stock sheds, repair shops, service rooms and lavatories.

Pittsburgh, Pa. C. W. STEVENS.

Inefficient Power Plant Management

POWER PLANT management involves the management of men as well as of equipment. Proper management should bring out the best there is in either man, materials or equipment.

To get the most out of man certain fundamental characteristics of his behavior must be understood. Unfortunately many power plant managers do not possess this fundamental knowledge and therefore fail to get the hearty response that would otherwise be given by their subordinates.

In one plant, the engineer tried several times to have the working conditions of his force improved so that a better grade of men would be attracted. He was fortunate in having one assistant who tried earnestly to operate the boilers economically, with the result that he burned fully 10 per cent less coal than either of the other two firemen. The management, however, failed to give him the recognition his superior efforts warranted, maintaining its doubtful practice of paying the lowest possible wages. The usual results followed.

Operation of the plant was carried on in three shifts. The coal consumption was 20 t. a day. One day the engineer was informed that his best fireman was to be transferred to another department in the plant, and a laborer from the yard assigned to take his place until another regular fireman could be secured. It was found that the reason the fireman desired the change was not only were higher wages paid in the new position, but the new job, which consisted of oiling all the bearings of the main shafting once a day, was a cleaner and easier job. It transpired that although the new work was of such a nature that a man with no previous training in it could do it, while competence as a fireman is attained only after years of study and experience, the man could earn a higher rate of pay in the new position.

Increase of firemen's wages to the level of the oiling job, it was stated by the management, could not be done, because the wages paid in other neighboring plants, whose product was similar, was no higher, and if an increase was allowed by them, they would be sharply criticized for such action.

Since a saving of 10 per cent of the entire coal bill was possible if all three men did their best and

were of the caliber of the fireman who was changing his job, two tons of coal could be saved daily. This meant a daily reduction of $14.00 in operating costs. To secure this kind of service by regulating the rate of pay to the higher level of the oiler, would require an increase of about a dollar a day for each fireman. This would have brought the scale on a par with that paid in central station plants, where, it is well known, a better class of fireman, resulting in a higher efficiency of operation, is employed. Our local central station leads all industrial plants in the matter of firemen's wages, and all wage increases come unsolicited to their men. How long would these central stations maintain their high record for boiler efficiency if their men were constantly leaving to take positions elsewhere?

Several years ago a local paper mill adopted a bonus system; it now has a waiting list of high grade firemen who are anxious to work there. The interest of the manager was secured by the engineer by telling him he could buy at least 15 per cent of his coal for $2 a ton. By paying the firemen a bonus of $2 per ton of coal saved, a reduction of 15 per cent in fuel consumption was actually realized. The grade of coal used cost $6.80 a ton in the bunkers. It was not hard, therefore, to convince the manager that he could afford to pay $2 for each ton saved. Every dollar invested in bonus payments returns $2.40 in savings with the further advantage that this saving is made before the dollar is spent, hence we have the safest kind of investment. Five years' operation of this plan netted a saving amounting to nearly $100,000. This saving was accomplished by interesting the management in the cost rather than the theory of steam generation.

Springfield, Mass. A. F. SHEEHAN.

Repairing Broken Pump Rods

SNAPPING OFF at the shoulder of the last thread quite often happens where brass or bronze pump rods are used. A new rod is then usually required causing inconvenience due to lack of availability of the pump. An easy, quick and reliable way to repair these rods is to drill a hole in the rod, twice as deep as the diameter of the thread, then tap this hole and screw in a steel stud. Drill a 3/16-in. or a ¼-in. hole through rod and stud and drive in a pin of corresponding diameter, to keep the stud from unscrewing. Leave stud long enough to correspond to the threaded end that was broken off and you will have a good rod without much delay.

Kansas City, Mo. J. F. STALEY.

Repairing Pump Plungers

WE HAVE in our power house a 10 by 6-in. duplex feed pump of prominent make. The plungers being badly scored, it was decided to renew them. Prices received from the manufacturers were $80 per plunger, making the total cost for the four plungers $320. Because of the cost the matter was temporarily held up.

In the meanwhile, buying packing and renewing it at least once a month involved considerable trouble, moreover the water leakage was quite bad as the pumps carried 160 lb. water pressure. Upon looking through one of our stock rooms, I noticed about 20 ft. of heavy brass tubing 6 in. external diameter and 5½ in. internal diameter. I had the old scored plungers turned down to 5½ in. diameter and the tubing cut to size and shrunk on.

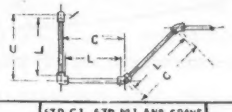
The results after six months' continuous operation are satisfactory and the saving of packing, water and steam is considerable. Besides these savings, the work of repacking the plunger is also saved; we have not repacked this pump in the past six months and little or no water leakage has thus far been evidenced. This scheme eliminated an outlay of $320 and was accomplished with no outside cost to the company.

I mention this in hope that some other engineer who is desirous of keeping his company's expenses down and who may be in the same position that I was, may take advantage of the idea and use it profitably.

Ampere, N. J. HERBERT O. MAY.

Method of Determining Overall Pipe Lengths

FOR FINDING the length of screwed pipe necessary to make up a pipe connection when the center-to-center distance of the fittings is known, the accompanying table



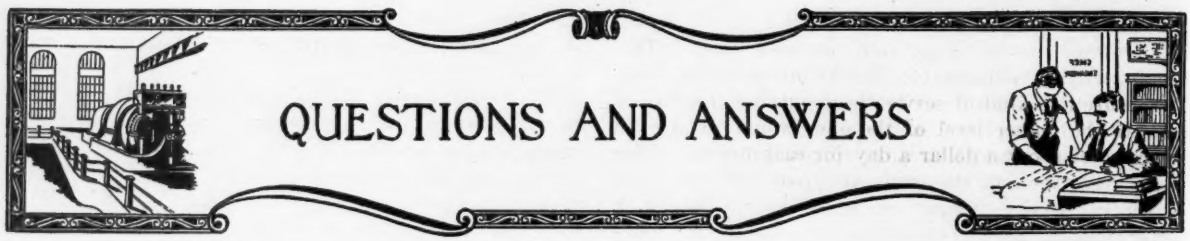
NOMINAL PIPE SIZE	STD. C.I., STD. M.I. AND CRANE "EXPL." EX. HEAVY M.I. FITTINGS: 2 TEES OR ELLS	1 TEE OR ELL AND 1-45° ELL	2-45° ELLS	EXTRA HEAVY CAST IRON FITTINGS: 2 TEES OR ELLS	1 TEE OR ELL AND 1-45° ELL	2 45° ELLS	EXTRA HEAVY CAST STEEL FITTINGS: 2 TEES OR ELLS	1 TEE OR ELL AND 1-45° ELL	2-45° ELLS
¼	7/8	13/16	3/4						
3/8	1-1/8	1	7/8						
½	1 1/4	1	3/4						
3/4	1-5/8	1-5/16	1						
1	1 5/4	1-7/16	1-1/8	2-7/8	2 1/4	1 5/8			
1¼	2 1/4	1 13/16	1 3/8	3 1/4	2 1/2	1 3/4			
1½	2 5/8	2 1/8	1 5/8	3 7/8	2 13/16	2			
2	3 1/8	2 7/16	2	4 5/8	3 7/16	2 1/2			
2½	3 1/2	2 3/4	2	5 1/8	3 7/8	2 5/8	4 3/8	3 5/8	2 5/8
3	4 1/4	3 5/16	2 3/8	6 1/4	4 5/8	3	5 1/2	4 1/4	3
3½	4 3/4	3 1/4	2 5/8	7 1/4	5 1/8	3	6 1/8	4 5/8	3 1/8
4	5 3/8	4 1/4	3 1/8	8 1/8	5 3/4	3 3/8	6 7/8	5 3/16	3 1/2
4½	5 7/8	4 5/8	3 3/8	8 7/8	6 1/4	3 3/4	7 3/4	5 11/16	3 5/8
5	6 1/2	5 1/8	3 3/4	9 7/8	7 1/16	4 1/2	8 5/8	6 5/16	4
6	7 3/4	6 1/16	4 3/8	12	8 1/2	5	10	7 1/4	4 1/2
7	9 1/8	7 3/16	5 1/4	13 3/4	9 5/8	5 1/2			
8	10 3/8	8 1/8	5 7/8	15 5/8	11 1/4	6 7/8	12 7/8	9 7/16	6
10	12 3/4	10 1/16	7 3/8	19 3/4	13 1/2	8 1/4	15 1/2	11 7/16	7 7/8
12	15 1/4	12	8 3/4	23 1/2	15 7/8	7 3/4	19 3/4	14 1/4	8 3/4

TABLE GIVING DISTANCE "D" TO BE DEDUCTED FROM THE CENTER-TO-CENTER DISTANCE OF TWO FITTINGS IN ORDER TO OBTAIN THE OVERALL LENGTH OF PIPE NEEDED TO MAKE CONNECTION

has been found convenient. It is applicable to cast-iron and malleable fittings of both standard and extra-heavy weights and is based on the fitting dimensions and tables of proper length of threads given in "Crane" and other authorities.

This table will be found useful not only by the pipefitter but also by any one having occasion to design or detail piping layouts.

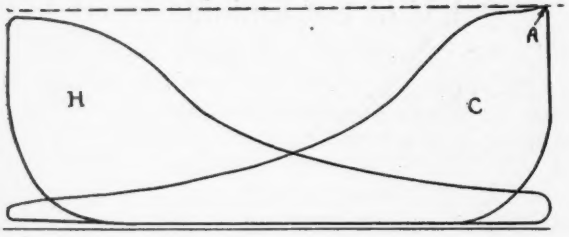
Philadelphia, Pa. C. F. FESSLER.



QUESTIONS AND ANSWERS

What Put the Hump on the Card?

I AM SENDING an indicator diagram taken on a variable load and would like to know the probable cause of the hump in the steam line at A of the crank end card. Please publish this for criticism. T. J.



PECULIAR ACTION ADDS HUMP TO CARD. CAN YOU EXPLAIN CAUSE?

Editor's note: It will be seen, since the dotted line is parallel to the atmospheric line, that the maximum pressure on the crank end is greater than that on the head end. Comments are requested also on this as well as on any other features of the diagram.

Corrosive Action on Bronze Valves

WE ARE unable to keep brass or bronze pipe fittings or valves steam tight in our lines, and have been obliged to replace the valves with those made entirely of steel. The water which comes from an 800-ft. deep well has been tested by different laboratories, the report from one of which is sent herewith, says the quality of the water for boiler feed is good and should have no corrosive action, but the fact remains that it has entirely corroded two fusible plugs in less than 6 mo. Both boilers are equally bad as to leaks and we have trouble even with the brass wire in handhole gaskets. Around the different joints and gaskets that leak, a hard caked mass that resembles a strong caustic material is accumulated on exposure to the air. It is difficult to remove this material with a chipping hammer but it readily dissolves and washes away when a hose is played on it.

Our two water-tube boilers are operating under 165 lb. per sq. in. gage pressure and have no superheaters. Natural gas is used through low-pressure burners, as fuel, and the flue gas temperature averages 350 deg. F.

I would greatly appreciate any information you can give me on my problem. J. J. B.

A. Caustic action, such as described, may be expected to take place when wet steam is made from water having the analysis submitted. It will not occur in the water lines.

When this water is heated, it is probable that it becomes decidedly caustic and attacks copper fittings largely because of this condition. Zinc alloys are particularly susceptible to this action. At the same time, the water can be regarded as decomposable into caustic and CO_2 under high boiler pressures and temperatures, and the steam would doubtless have an acid action if allowed to collect and condense. Corrosive action, however, would not occur in dry steam lines.

Grounding the Neutral

REFERRING TO THE question of D. D. H. in the October 15 issue of Power Plant Engineering, in regard to the advisability of grounding the neutral of his system, I believe that the lessened potential to ground, caused by the grounded neutral, will be important in his case as well as in large public service systems. With the neutral grounded, the strain on the insulation of the system (generator, line and transformers) to ground, is only 58 per cent of what it would be with the neutral ungrounded. This is a protection against breakdowns that is worth taking into consideration.

In the purchase of three-conductor cable, if the neutral is to be grounded, it is possible to decrease the thickness of the "belt" insulation—which is the part surrounding all three conductors and between them and the sheath, and therefore between them and the ground—and thereby reduce both the cost of the cable and its diameter. If the thickness of the belt is left the same as that around each of the conductors—which should be the case if the neutral is not to be grounded—and the neutral is grounded, greater protection against breakdown is provided. In either case there is a saving owing to the grounding of the neutral.

Westfield, N. J. G. H. MCKELWAY.

Engine and Boiler Problems

I WOULD APPRECIATE your counsel on the following:

1. Of what material are engine wristpins and crankpins made? Why is this metal used?

2. If you had to turn up a new wristpin in a lathe, would you harden it? If so, explain the best method to use. What is the composition of this metal?

3. The wedge on the crank box of our engine, indicated in Fig. 1, measures 1 /16 in. at bottom of wedge, 2 in. at top, and is 8 in. long. The bolt, which is a continuation of the "wedge gib," has a pitch of 10 threads per inch. The bolt threads through an "eye" which is made integral with the wedge. Can I tell, in thousandths of an inch, how close together I have moved the boxes by observing the number of "squares" the nut turns when driving the wedge? The nut is hexagonal.

4. How would you figure the area of that part of a boiler front which is indicated by A in Fig. 2 herewith?

If the boiler is 18 ft. long, what would be the cubical contents of this space?

5. Given a 72-in. h. r. t. boiler having 33 sq. ft. of grate surface, and operating under natural draft. The coal used averages 14,200 B. t. u. per lb. The feed water is 200 deg. F. What would be the maximum amount of steam that could be generated when hand fired? The builder's rating is 150 hp., and the boiler is designed to have 1500 sq. ft. of heating surface.

6. In what position should a crankpin be when "pulling up" on the adjusting bolts?

7. Same with reference to wristpin?

8. What is the proper clearance to use between the upper shoe and the crosshead guide on an 18 by 42 by 70-in. engine?

A. For use in large steam engines, crankpins and wristpins or "crosshead pins" as they are now usually termed, are generally made of a low carbon steel such as open hearth steel. In some cases where crank discs are employed, the pin is cast integral with the disc and consists of "steel casting" or "semi steel." This metal is used because it is sufficiently strong and has good wear resisting qualities. The comparatively low surface speeds of these bearings do not warrant the use of special alloy steels and heat treatment.

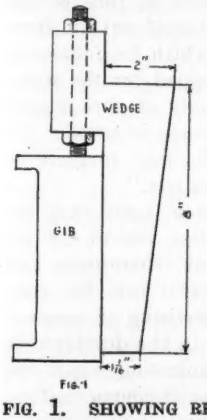


Fig. 1

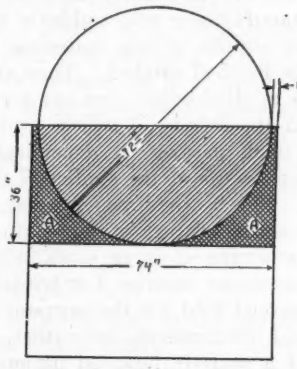


Fig. 2

FIG. 1. SHOWING RELATION OF WEDGE TO GIB IN CRANK BOX OF ENGINE

FIG. 2. SHOWING SIMPLE METHOD OF DETERMINING AREA OF IRREGULAR PORTION OF FACE OF FURNACE BY SUBTRACTING AREA OF BOILER HEAD FROM AREA OF SECTION OF FURNACE

2. It is best to obtain a new crosshead pin from the manufacturer. If I were turning up such a pin, I would grind it to a finish and polish it. I would use a low carbon or machinery steel and not harden it.

3. If the wedge were moved its entire distance, that is, 8 in., it would move the boxes 2 in. — 1-1/16 in. = 15/16 in. or 0.9375 in. For 1 in. of wedge movement, the boxes would move $\frac{0.9375}{8} = 0.1172$ in. Since the screw has ten threads per inch the movement of boxes per turn of thread would be $\frac{0.1172}{10} = 0.0117$ in. If the nut is hexagonal, the movement per "square" or flat side would be $\frac{0.0117}{6} = 0.002$ in.

4. The area of a circle 72 in. dia. = 4071.5 sq. in. The area of the cross-sectional part of the rectangular part of the boiler front = 36 × 74 = 2664 sq. in. The area of the two double cross-sectioned parts A, Fig. 2, would then be: $2664 - \frac{4071.5}{2} = 628.3$ sq. in. Each part would then have an area equal to $\frac{628.3}{2} = 314.1$ sq. in. If this double cross-sectioned space extends the entire length of the boiler, the corresponding cubical contents would be 628.3 × 18 × 12 = 135,713 cu. in. or $\frac{135,713}{1782} = 78.5$ cu. ft.

5. Assuming your boiler pressure to be 100 lb. per sq. in. absolute pressure, we find, by consulting steam tables, the total heat in 1 lb. of steam at this pressure to be 1186.3 B. t. u.

Feed water temperature being 200 deg. F., the total heat supplied to 1 lb. of steam under given condition would be 1186.3 — 200 + 32 = 1018.3 B. t. u.

B. t. u. of coal given is 14,200. Assuming ash content to be 9 per cent, the heating value of 1 lb. combustible will be $= \frac{14,200}{1.00 - 0.09} = \frac{14,200}{0.91} = 15,600$ B. t. u.

Assuming an efficiency of boiler and grate to be 65 per cent, which would be a liberal assumption for your condition, the actual amount of heat transferred per lb. combustible will be $\frac{15,600 \times 65}{100} = 10,140$ B. t. u.

Assuming a maximum rate of firing by hand as 30 lb. per sq. ft. grate surface per hour, since your grate surface is 33 sq. ft., your rate of combustion may be as high as 30 × 33 = 990 lb. per hr.

Under these conditions, the heat that may be transmitted per hour to the water is 990 × 10,140 = 10,038,600 B. t. u.

The limiting quantity of water that may be turned out into steam under the conditions assumed would then be $\frac{10,038,600}{1018.3} = 9850$ lb. per hr.

6. It is most convenient to adjust the screws at the crankpin end of the connecting rod when the crankpin is in the upper half of its swing, but if adjustment is to be made at both ends of the connecting rod it would be best to locate the crankpin as indicated in answer 7.

7. The crankpin should be at or near the head end dead center, particularly if the adjusting screws in the connecting rod are located vertically. Where they are placed horizontally, the position of the connecting rod is not so important because of the greater accessibility.

8. If the engine is running "over," in which case the thrust is on the lower guide, the crosshead should fit freely in the guide. If the engine runs "under" the crosshead should have a "sliding" fit. The adjustment should be such that there will be no "slapping" when the engine is running.

EDITORIAL COMMENT

Progress Results from Accumulated Information

Within the power plants throughout the country are hundreds, perhaps thousands of devices in use which are known only to the men in a single plant. These devices work well, serving a purpose better than any other known equipment, yet the ideas have not traveled beyond one plant or perhaps a few local plants. Thus it happens that engineers in one city may be familiar with the problems encountered and the solutions worked out in the plants of their community but a hundred miles away the power plants seem to have considerable unfamiliar equipment. A few hours spent in an unfamiliar plant, exchanging ideas with the chief engineer will bring out many things of value to both the plant visited and the visitor.

Progress in different parts of the country is along different lines. Engineers in one section become specialized because of local conditions. Along the Mississippi Valley, for example, are a number of wood working factories that use the wood waste for fuel. The success they have obtained is rather unusual. It has required a great amount of experimenting with grates, stokers, furnace designs, conveying equipment, draft conditions and fuel bed conditions. This work, having been done, should be of value throughout the entire country where wood waste is used as fuel.

Out in the northwest section of the country another type of wood fuel is used extensively and still another in the lumber industry of the South. Each section can be of assistance to others by relating its troubles and solutions in detail.

In all plants, where progressive engineers are employed, experiments are going on continuously, not only in fundamental principles but in details of design and operation. The proceedings of various engineering societies are filled with information on engineering problems of the day. All too few, however, are the discussions, verbal and printed, on the details of operation which have been developed in the power plants throughout the country.

Progress in any industry is the result of a united effort on the part of everybody in the industry to learn and teach the best ways of accomplishing results. The results of experiments which you as an engineer are trying out should be made known to other engineers so as to forestall duplication of effort, add to the general fund of engineering information and advance the profession as a whole by the steps you have taken. The mediums through which such information may reach those interested are, naturally, engineering societies and the technical press. Your profession knows you by the works you have done with which it is familiar.

Is Europe Necessary for Our Scientific Future?

Echoing the lamentations of Europe on the decline of scientific research, Dr. Kellogg, secretary of the National Research Council, declares that "In the past the great research institutes and universities of Europe have supplied the world with a wealth of scientific knowledge and we in the United States, who have lagged far behind in our own researches in pure science, have profited perhaps more than any other country.

"Even the magnificent laboratories which have been established by so many of our major industries have very largely confined their efforts to a practical application of the information furnished by the pure science research carried on in Europe," he continues. "Now they are in exactly the same position as that of the manufacturer who suddenly finds himself cut off from his supply of raw materials from which he fabricates his finished product. They are equipped for the study of applied science but not for the study of pure science on the results of which applied science is based. All human progress is dependent in the last analysis on the results of the studies of the scientists."

Slowly the facts are being driven home that the scientific future of our industries lies, not in the expenditure of large sums, magnificent laboratories and beneficent salaries for scientists drawn into the commercial field for the purpose of advertising or commercial development, but rather, it lies in the development of a soundly financed national organization which can be entirely isolated from all elements of commercialism.

Considering all things, it is perhaps well that such a crisis is developing now, during a period of prosperity, rather than at a later period when business is not so good or during a national crisis when time is limited. Certainly Secretary Hoover's campaign in this connection is worthy of the financial and moral support of all engineers and industrial organizations. Without detracting from the credit deserved by Europe for past developments, there is every reason to believe that, with financial support and proper administration, we can develop our own scientists.

Water Resources

Transportation, power and irrigation are the important benefits to be derived from our water resources and the importance of these is stressed in the message of President Coolidge to Congress.

Important projects which are under consideration are the disposal of Muscle Shoals power which is discussed in a news article in this issue, extension of the Mississippi system, development of the lower Colorado River and the Great Lakes to Atlantic waterway. It is usual that, in any given case, either transportation

or power will be the more important consideration but neither should be neglected in planning development.

The President urges, sanely, that waterways should be taken up as a national system, completing trunk lines first, then making extensions, leaving projects of purely local value for development by local agencies. This is the method followed in road planning and construction and should not be disturbed by local selfishness or political greed. The message urges that competent engineering reports be made the basis for action in such matters as the Great Lakes to Gulf and to the Atlantic waterways and the method for restoring Great Lakes levels. Evidently these are matters where political preferences should be put aside and action based on engineering and economic considerations, a fact which is evident to the President's logical mind.

Reclamation and irrigation projects are more frequently tied in with power than with transportation, the power development being secondary but vital to the welfare of the community which comes into existence as a result of reclamation work. No new projects are now possible, as completion of those already started will absorb available funds for a number of years, but investigation and careful planning for promising projects will give intelligent progress in years to come and continue the satisfactory record that has been made.

As the President states: "Water is an irreplaceable resource. Its precipitation cannot be increased. Its storage on the higher reaches of streams, to meet growing needs, to be used repeatedly as it flows toward the seas, is a practical and prudent business policy." That all power which can, economically, be developed, is obtained from it is an important part of utilizing our resources and is distinctly the duty of power-plant engineers.

Off Duty

Some three and a half centuries ago, in the quaint town of Delft, Holland, an obscure man, who ran a dry-goods store, spent all of his spare time grinding tiny pieces of glass. His neighbors thought him a bit "cracked" but, since he minded his own business and harmed no one, they put up with him. But while they sniggered, this Dutchman, whose name was Leeuwenhoek, looked for the first time into a new world—a world peopled with thousands of different kinds of tiny beings, some ferocious and deadly, others friendly and useful, but all of them strange and new. For Leeuwenhoek was the first of the microbe hunters.

I cannot recount the story of Leeuwenhoek's life here but those who are interested will find it charmingly told in a recent book by Paul de Kruif. In this volume, de Kruif not only tells of Leeuwenhoek's almost idiotic love for grinding lenses and peering through them, but follows this with the story of the long line of microbe hunters that came after him—the men to whom we owe all our present day knowledge of disease and its prevention.

Thanks to these searchers, these indomitable gropers, we have learned much since the day when Leeuwenhoek first put a bit of tartar, which he had scraped from his teeth, under his microscope and gazed in spellbound astonishment at the thousands of strange wiggling creatures he found there. From microbes a ten thousandth of an inch long we have gone down, down into the submicroscopic world, into the molecule, through the atom, until the Leeuwenhoeks of today deal with things so small that you could put more of them in a drop of water than there are drops of water in the entire Atlantic Ocean; for such is the size of an electron. But still they are not satisfied and today, as in Leeuwenhoek's day, you will find them, not only with microscopes but with other strange devices, everlastingly at it.

In the General Electric research laboratory not long ago, Dr. Coolidge, who for many years has been shadowing our friend, the electron, in his native haunts, devised a new tube—a cathode ray tube, he calls it— for shooting a ray of electrons out into the air. This tube produces as many electrons per second as a ton of radium and that, we might add, is a great many electrons.

Radium, you know, is constantly disintegrating and in doing so is shooting out electrons. This new tube of Dr. Coolidge's does the same thing but at a much greater rate. So much more concentrated are the rays of the tube that many startling experiments have been conducted. Crystals of calcite apparently become red hot coals when exposed for a moment to the rays, but they are glowing with cold light. Ordinary salt is turned brown and a considerable time elapses before it again becomes the colorless substance it usually is. Bacteria and small flies are almost instantly killed by exposure to its rays.

In one experiment a small portion of a rabbit's ear was subjected to a short exposure of the ray. Exposure of a tenth of a second caused a temporary loss of hair over the area. When the exposure on another area was increased to one second a scab was formed. When it fell away it took the hair with it and weeks later the area became covered with a profuse growth of longer snow white hair. A picture of this bunny's ear is shown on page 1307. A minute's exposure produced a scab on both sides of the ear and when they fell away a hole was left which became fringed with white hair.

And so, once more, in a world which has been pretty well explored, scientific research brings us something new. Electrons are small—exceedingly small, but traveling at the rate of 150,000 mi. *per second* as they do when they leave this tube, they are capable of producing strange effects. To what use the tube can be put is not known but they are not worrying about that at the G. E. laboratory; in fact, that's the last thing they seem to concern themselves about.

And that is the point I want to emphasize, the fact that these men working on the forefront of science are not concerned with dollars and cents. Like Leeuwenhoek, they are interested in what they see. Leeuwenhoek did not dream that the observations which he made were to lie at the foundation of the great science of bacteriology. He had not thought of helping humanity. As a matter of fact, he was a selfish, persnickety old fellow, who would not even let anybody look through his best microscope. That pleasure he reserved for himself only.

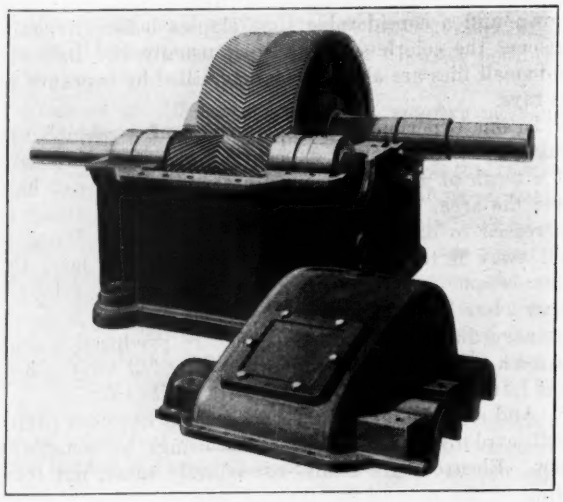
But it is this force inherent in the man of science that has given us all we have today. Only the overpowering desire to *know* is at the bottom of all scientific research. Fame, recognition and monetary return do not enter into it. The chances are that if any of these were the objectives, scientific research would have made as poor a showing in the world as have some of the other great branches of human endeavor.

POWER PLANT ENGINEERING DEVELOPMENTS AND NEWS

New Herringbone Speed Reducer

DOUBLE HELICAL construction which neutralizes end thrust, overcomes shock and reduces noise of action has been used in the new design of speed reducer just brought out by the D. O. James Manufacturing Co. of Chicago.

In this reducer, there is no groove in the center, the two opposing helical teeth coming into direct contact.



HERRINGBONE CONSTRUCTION OVERCOMES END THRUST, SHOCK AND NOISE

The effective width of the gear, for a given overall width is therefore not reduced.

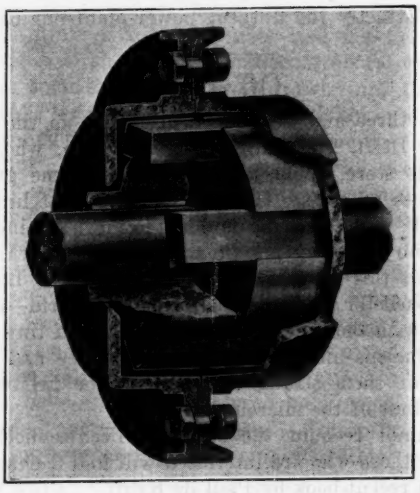
Generation of the individual teeth is accompanied by a curve or twist which so operates as to present the same profile in the normal (right angles to the helix angle) and to the diametral (right angles to the face) planes of the gear. Thus accuracy of action is obtained.

Involute tooth construction with 20-deg. pressure angles and 30-deg. helical angles was adopted, the addendum and dedendum being respectively 0.8 in. and 0.1 in. The overlap is approximately 50 per cent, making the action continuous, smooth and comparatively noiseless. Two teeth are always in mesh in the plane of axis. Because of the lack of shock, great loads may be carried with high efficiency by small gears of this construction. This permits of big reduction ratios and high rim speeds. Less shock, vibration and friction lead to long life, and reduced power driving equipment. Compactness due to few gear reductions results in a smaller space requirement. Backlash is practically eliminated.

Herringbone reducers are now being manufactured by the James Company for reduction ratios from 2 to 1, to 150 to 1, and able to carry loads of from 2 hp. to 200 hp. These reducers are made to fill the demand for heavy, rugged, durable service, especially where heavy equipment is driven; as in rubber, glass, chemical, lumber, paper, sugar, and steel mills. From the foregoing paragraphs, it can be seen that the herringbone gear when properly manufactured is an excellent type for use in speed reducers.

Flexible Coupling Overcomes Misalinement

INCREASING adoption of direct connection of motive power to machinery has created a demand for flexible couplings by which off-set or angular misalinements may be overcome. A new design of flexible coupling for



FLOATING KEYS IN BATH OF OIL QUIETLY AND DEFINITELY CORRECT MISALINEMENT

this purpose, shown in the accompanying illustration, is announced by W. H. Nicholson & Co., of Wilkes-Barre, Pa.

This coupling consists of two hubs that are keyed to the shafts to be connected. These hubs are connected together by means of loose-fitting, floating keys having beveled sides. In the smaller sizes of couplings, three of these keys are used; while on larger sizes, five are employed.

When in motion, the centrifugal force, it is claimed,

throws the floating keys out into the slots, causing them to operate smoothly and quietly; the interior of the coupling casing being supplied with an oil bath. When the torsional load is applied, the centrifugal force of the floating keys is overcome and they recede to the bottom of the slots. A film of oil is maintained between the keys and slots at all times, allowing a free lateral float of the coupling hubs. Any wear that might occur in the sides of the keys after long years of service is taken care of by the centrifugal force. In case of accident or wear, in which new floating keys are required, they may be quickly and easily replaced since any machine shop can supply such keys at short notice.

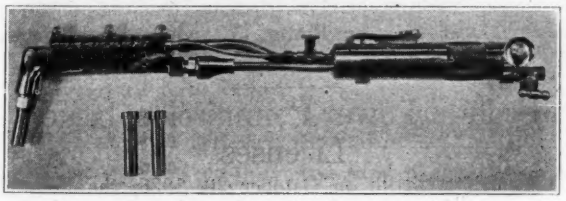
It is claimed by the manufacturer that the strength of the floating keys is so much in excess of that of the shaft that any given size of coupling will withstand a greater load than can be carried by the shaft itself. The floating keys, as well as the hubs, are made of steel and the casing of steel casting. A gasket is used between the flanges to insure a tight fit, making it impossible for oil to fly out.

Lubricating oil may be added through an oil filling plug in one of the flanges of the casing. The oil level maintained is such that oil will not leak out around the hub when the coupling is not in motion. A heavy oil is recommended for use as lubricant.

When in operation and connecting two shafts which are misalined, the keys have a slight rocking action during each rotation. The centrifugal pressure maintains an oil film between the floating keys and the slots, thus preventing a metal to metal contact when the load is transmitted.

Cutting Torch Uses Illuminating Gas

FOR USE WITH illuminating and by-product gases, a new and interesting type of gas cutting torch has recently been placed on the market. This is designed to reduce cutting costs by using city gas, which is, in



NEW GAS CUTTING TORCH IS CONSTRUCTED OF BRONZE FORGINGS AND SPECIALLY DRAWN TUBING

most cases, much lower in cost than other gases. The principal features of the torch are shown in the accompanying illustration.

One of the important parts of the torch is the superheater, which heats and expands the cutting oxygen and the preheating gases and raises the temperature of the cutting oxygen to approximately 100 deg. C., or 212 deg. F., prior to combustion. This is designed to increase the temperature of the gases at the torch tip, to increase the rate of flame propagation in the burning mixture and to reduce the oxygen consumption. This superheater is a Bunsen burner contained within the torch and burning illuminating gas, which heats the oxygen as it passes through a series of copper coils. It is stated that this is an exclusive feature of this apparatus.

The purpose of heating and expanding the oxygen in conjunction with the illuminating gas is to give a better penetration into the metal, a narrow kerf and sharp, clean edges, as well as fast, smooth cutting and to prevent metallic slag on the underside of the cut. It is designed to prevent case hardening of the surfaces cut and to leave them in practically the same state as the original steel.

The torch, made by The Alexander Milburn Co., Baltimore, Md., is ruggedly constructed of bronze forgings and specially drawn tubing. The high-pressure cutting oxygen is controlled by a thumb valve which remains fixed in either open or closed position. The arrangement of the gas tubes is designed to give the torch great transverse strength. It is 21 in. long and is furnished with a complete range of tips for light, medium and heavy cutting.

The equipment is designed to cut heavy plate and slabs, structural shapes, billets and other material. It operates on either city illuminating gas or natural gas.

New Horn Gap Switch

FOR OUT-DOOR disconnection and sectionalizing service, a new triple-pole, horn gap switch is being produced by the General Electric Co., bearing the designation TA-1. It is for 400 amp. and is manufactured in ratings of 15,000, 25,000, 37,000, 50,000 and 73,000 v., for horizontal mounting and for either manual or motor operation. It is a tilting insulator switch with high-pressure, self-alining contacts, and is made up of single-pole units mounted on galvanized steel channels with three standard pin-type insulators per pole. The middle insulators of each pole carry the movable blades and are tilted on a common, solid square shaft.

Two hard-drawn copper half cylinders, enclosed in a housing and pressed together by double-coil steel springs, form the self-alining contacts. The blades, pinned to the tilting insulator caps to allow a slight motion, enter the floating stationary contacts with a wiping action, from any reasonable angle, and thus secure clean contact.

Manual operation may be had by means of a crank attached to the main shaft and connected with a pipe directly to an operating handle beneath the crank, or by means of a crank attached to the main switch shaft and connected indirectly through a bell crank and countershaft to the operating handle. By means of the latter arrangement, the operating handle may be at some distance from the shaft. The operating mechanism may be locked to open or closed position.

UNITED STATES CIVIL SERVICE COMMISSION announces an open competitive examination for junior engineer and deck officer to fill vacancies in the Coast and Geodetic Survey at an entrance salary of $2000 a year. Applications will be rated as received at Washington, D. C., until March 29, 1927. Full information and application blanks may be obtained from the Commission at Washington or at the post office or customhouse in any city.

89,000-Hp. Turbine-Generator Unit Started

ON NOV. 29, steam was turned into the 89,000-hp. turbine unit recently completed by the Buffalo General Electric Co. at its River Station, by William R. Huntley, president of the company.

Mr. Huntley said: "This marks completion of a job on which we have been working about a year. Not many years ago, 5000 hp. was considered wonderful but today, by a turn of the wrist, we put at work a machine of 88,000 electrical horsepower. In terms of man power, it adds nearly 1,000,000 to the electrical servants at work in this territory. That the machine runs without the slightest trouble reflects great credit upon our engineers who have lived with this job from the time it was conceived until it is an actuality."

This machine is, by 10 per cent, the largest now in service and is served by four pulverized fuel boilers and the largest transformer built. Reinforced concrete caissons were sunk 40 ft. to bed rock to carry the 750 t. weight of the unit and 200 t. of steel and concrete foundations. The transformer weighs 122 t., holds 9450 gal. of oil and uses 180 gal. of water a minute for cooling. In erection, two 100-t. cranes were used for handling parts.

Boilers burn 14 t. of coal each an hour and supply 670,000 lb. of steam.

Addition of this unit brings the capacity of the River Station to 200,000 electrical horsepower, the design being entirely by the engineering department of the company and construction by the Derdenger Construction Co. of Buffalo.

Wilson Substation Contains the World's Largest Transformers

USE OF substations for reducing the high transmission voltage to that needed for use in distribution systems and on motors and lighting transformers is well understood by the readers of Power Plant Engineering, also the use of the transformers for stepping down voltage and the carrying away of the heat generated in the windings by means of oil surrounding the coils and air-cooled radiating fins on the outside of the casings.

In the Wilson substation power is received over a transmission line 105 mi. long, tying together the lines of the San Joaquin Light & Power Corp. and the Great Western Power Co. of Brighton substation, near Sacramento, Cal. The transmission line and substation represent an investment of $2,750,000, and this forms the largest link in the California interconnection system.

Current now comes to the substation at 165,000 v., but later will be increased to 220,000. The capacity of the substation is 90,000 kw. or 120,000 hp. with provision for increasing this capacity to 240,000 hp.

Transformers at the Wilson substation are, in physical dimensions, the largest ever built, as stated by the General Electric Co., which built all machinery for the plant. These transformers are 28 ft. 3 in. high, 22 ft. long, 14 ft. 9 in. wide over all. Core and coils weigh 78,000 lb.; tank and fittings weigh 63,000 lb. and the oil 120,000 lb., giving a total weight for each transformer of 261,000 lb. Oil to fill each transformer is more than 16,650 gal. and the two auxiliary tanks having a capacity of 16,450 gal. act as a reserve and are mounted on concrete saddles near the condenser building. Transformers are four in number, one being an extra for emergency service, and have been designed to operate at the maximum future voltage of 220,000. Test voltage, which is said to be the highest ever applied to windings on commercial apparatus, was 481,000 v.

For the cooling system a new device has been applied, permitting air to be blown at a 4-oz. pressure and in the amount of 8000 cu. ft. per minute over the radiating cases by a large fan which in turn is driven by a 50-hp. motor. Even with the air supply cut off, the transformers will carry 57 per cent of their load, which is 24,000 kw. each for the 220,000-v. winding, 30,000 kw. for the 125,000-v. winding and 40,000 for the 10,640-v. winding. Leads from the 10,640-v. winding, which run from the transformers to the substation building, consist of three 750,000 c.m., three-conductor, lead-covered cables, which are insulated for operation of 15,000 v. and, since they are, it is stated, the largest cables of this voltage ever manufactured, had special dies made for the cable-drawing machinery.

Most imposing of all the structures of the substation is the condenser building, housing the synchronous condensers, which is of structural steel and concrete, 88 ft. by 79 ft., and 56 ft. high. The present structure is to accommodate two 25,000-kw. condensers and is planned to permit of an addition of equal size with the necessary control and switching equipment. The building is equipped with a 75-t. crane for handling the heavy transformers and a smaller 5-t. crane for quick handling of the lighter equipment.

This substation was designed by J. A. Koontz, electrical engineer and C. W. Mardell, chief engineer of the Great Western Power Co. It was built by T. J. Tennant, superintendent of construction, under the direction of W. G. B. Euler, general superintendent of all Great Western construction, and is being operated under the direction of C. F. Benham, chief of operation of the Great Western Power Co., whose headquarters are in San Francisco.

Federal Power Commission Issues Licenses

AT ITS MEETING on October 20, 1926, the Federal Power Commission authorized the issuance of the following licenses and permits:

To the Carolina Power & Light Co., a license for 50 yr. for a project on the Big Pigeon River, Haywood County, N. C. This is to consist of a concrete arch dam 130 ft. high, a 6⅓-mi. tunnel and penstock and a power house with an initial installation of 35,000 hp. to be ultimately developed to 70,000. This is the same project for which a preliminary permit was issued to the Pigeon River Power Co., which, however, has surrendered its rights.

To the Sierra and San Francisco Power Co., a license for 50 yr. for a part of the complete project on the Stanislaus River in California. This is in connection with an irrigation project being carried on and the proposed power development will be about 34,000 hp.

To the City of Seattle, Wash., preliminary permit for 3 yr. for a power project on the Skagit River, designed to utilize the entire head of the river between the Canadian boundary and a constructed power house owned by the city. The proposed development is to be built in three stages, consisting of three dams each with power structures. The estimated power capacity of the project is 260,000 hp. Power will be transmitted to Seattle for general public utility purposes.

To E. L. Hill and C. L. Spencer, for a proposed power project with an ultimate installed capacity of 90,000 hp. on the Suwanee and St. Mary's Rivers in the states of Florida and Georgia.

The Appalachian Electric Power Co. has applied for a license for an 80,000-hp. power project in the New River near Radford, Pulaski County, Va.

The commission also announces that its sixth annual report is nearing completion and will be ready for distribution on or about November 29. Copies will be furnished without charge to those interested.

Pacific Gas & Electric Co. Completes Fordyce Dam

AT LAKE FORDYCE, one of the Pacific Gas & Electric Co.'s string of storage reservoirs far up in the snow-shed region of the Sierra Nevada mountains, has been completed the Fordyce dam and, with its rock wall 47 ft. higher than before, awaits the coming of the winter floods. This achievement completes the conservation of the waters of the South Yuba river, adds to the output of four hydro-electric plants, provides the farmers of a large territory with more water for irrigation and adds a large sum yearly to the value of their crops.

Lake Fordyce lies in a high mountain bowl 6300 ft. above sea level. Between it and the railroad there is a ridge 800 ft. higher. Over that rocky summit of 7100 ft. altitude runs a 9-mi. mountain road to the lake. Over that road, carved and blasted out of granite, the builders had to haul not only hundreds of tons of supplies, but also two steam shovels, cranes, a rock crusher, two concrete mixers, several locomotives and a string of cars.

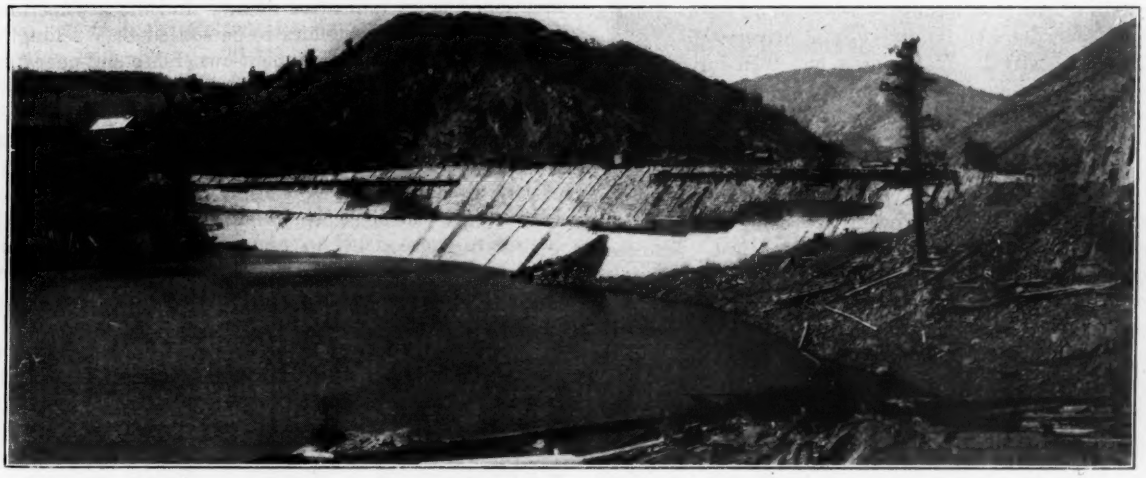
Fordyce has been raised three times. The original dam was built in the early '70's, not to impound water for making power nor for irrigation, but to supply water for hydraulic mining. In time it became part of a power system and the capacity of the storage reservoir had to be increased. Before the latest raise it could store, in round numbers, 20,000 acre feet; now it is ready for 46,700 acre feet. The dam itself is 116 ft. high and has a crest nearly a fifth of a mile long. At base the rock fill has a width of 300 ft., and tapers upward at the natural angle to 10 ft. at the top.

Ed Roening, who helped to build the original dam more than half a century ago, is still at Fordyce, a laketender for the company.

Verdicts of States on Control of Public Utilities

RECENT state elections had an important bearing, in several states, on the development of the light and power industry.

California and Oregon held referendums on putting these states into hydro-electric development and both states decided to stay out. As this is the third time that California has decided the same way by over 2 to 1, it would seem that the matter ought to be settled. Oregon turned thumbs down by 4 to 1, so that might well be considered a decision.



UPSTREAM FACE OF FORDYCE DAM A SHORT TIME BEFORE COMPLETION

New York, by electing Governor Smith and a Democratic ticket, practically refuses a permit to the St. Lawrence Valley Power Corporation for development of power on the St. Lawrence River as, after January 1, 1927, Governor Smith can veto any permit issued by the State Water Power Commission and he is asking that action on this permit be delayed until after that date. Project for a regulating reservoir on the Salmon River is also likely to be held up.

Colorado voted 2 to 1 to retain "home rule" for its public utilities rather than put them all under a state commission.

The Ohio fight over the make-up of the Public Utilities Commission will probably be continued as a result of the re-election of Governor Donahey, who feels that certain utilities are unduly favored.

Development of the Conowingo plant is furthered by re-election of Governor Ritchie of Maryland, who favors it. It has received approval of the Federal Power Commission and of the Public Service Commissions of Maryland and Pennsylvania.

Re-election of Governor Paulen of Kansas probably ends the effort to have public service companies there pay taxes on the same valuations as used for rate-making. These tax valuations were greatly raised under former Governor Davis but the courts enjoined collection of taxes on the increased valuations. His defeat by Governor Paulen seems to insure that the investigation of rates will go forward in an orderly manner.

On the whole, the results are favorable to utility development, indicating a sane and fair attitude of the voters towards the companies which give them such indispensable service.

Power Commission Pressed to Permit Plants in Tennessee

BUSINESS interests of Tennessee, including chambers of commerce, boards of trade, and other civic organizations, as well as educational bodies and political leaders, the latter under the leadership of Governor Peay, of Tennessee, are pressing the Federal Power Commission at Washington for action on the applications before the Commission for preliminary permits which would eventually result in developing 11 hydroelectric dam sites on the Tennessee River above Chattanooga and the Clinch and Powell Rivers.

This activity in Washington has been intensified by the announcement of Government-ownership-and-operation advocates in the Senate who declare that no action will be taken at the coming short session of Congress on the proposal to pass final Muscle Shoals legislation.

Applications for the preliminary permits on the Tennessee, Clinch and Powell are being made by the Tennessee Hydroelectric Co., the East Tennessee Development Co. and the Union Carbide Co. It is no secret in legislative and executive circles in Washington that the application of the East Tennessee Development Co. is considered favorably by the Federal Power Commission, as being in accordance with the plan of development most approved by the Corps of Engineers of the Army.

Unfortunately, when these applications were filed last year, Senator Norris, of Nebraska, at that time chairman of the Senate Committee on Agriculture and Forestry, desired more information than he then had as to what would be the effect on the increase of power at Muscle Shoals by the building of storage facilities and other dams up the river. He introduced in the Senate a resolution forbidding the Federal Power Commission to grant the preliminary permits alluded to, up the river, until after final Muscle Shoals legislation. Coincidentally, the Congressional Joint Committee on Muscle Shoals, of which Senator Deneen, of Illinois, is chairman, dealt with the subject of possible dams up the river and storage facilities there, during its negotiation with the associated power companies which were the successful bidders for Muscle Shoals. These two facts, coupled with others, the latter more of a political than an economic character, have caused the delay in action on the preliminary permits by the Federal Power Commission.

It is to overcome this delay that the business and educational interests of Tennessee are now sending representatives to Washington to urge action by the Federal Power Commission. Their visits to Washington have developed the expression of impressions by Federal Power Commission officials that Senator Norris and Senator Deneen do not wish the upper Tennessee permits acted upon yet.

These impressions are incorrect, according to information obtained by the Washington correspondent of Power Plant Engineering. In the case of Senator Norris, the latter has expressed himself directly to the writer to the effect that, when he held hearings on his resolution, it was only for the purpose of obtaining information; and to the effect that the people of Tennessee made such a strong showing at the hearings on his resolution, in regard to their necessities for increased power facilities, that Senator Norris felt Tennessee should go ahead with its program and that, under the law, there is nothing for the Federal Power Commission to do but to issue the preliminary permits. Senator Deneen feels the same way. Senator Norris is acting so fairly in regard to the matter that he has sent word of his true position to Federal Power Commission officials, and has offered to appear before the Commission in person to give his views, if necessary.

This situation in regard to the Tennessee permits mentioned is an indication of how difficult it sometimes is for matters of economics to be settled in Washington on their merits. Government-ownership-and-operation advocates who dream, idly, of course, of the possibility of the Coolidge administration fathering a plan to have the Government invest hundreds of millions of dollars in the 11 more dams on the upper rivers, while the Wilson dam at Muscle Shoals is still in the legislative hopper, are among those who spread reports in Washington to cause delay in granting preliminary permits such as these wanted by the people of Tennessee. Incidentally, the general business interests and the power executives of Tennessee have testified that capital is idle and waiting to go into these proposed dams. It should be mentioned that Senator Norris is not one of the Government-ownership-and-operation advocates who are attempting to retard action.

Tennesseans coming to Washington to urge action, led by Senator Tyson, of Tennessee, are asking for a hearing before the Federal Power Commission on the preliminary permits. These requests are uncovering many queer reasons for delay, in addition to the misapprehensions already mentioned. One queer reason uncovered in conferences with the Secretary of War, the Secretary of the Interior, and other Power Commission officials on November 17 and 18, is that some members of the Alabama delegation in Congress seek to prevent action by the Commission because of the following: They wish none of the power from the Wilson dam at Muscle Shoals exported from the state, in the hope that, if that can be arranged, a great new industrial center will be built up in Northern Alabama around Muscle Shoals; also, they wish the power from the storage facilities and the 11 dams on the upper Tennessee, Powell and Clinch rivers to be so operated

that it will augment the Muscle Shoals power. That attitude brings about the queer situation that some members of the Alabama delegation not only will not give their sister state, Tennessee, any of the Muscle Shoals power, but that they are actually trying to reach out 400 mi. above Muscle Shoals, where the 11 dams are proposed, and take away from their sister state, Tennessee, a large proportion of its power to be added to the Muscle Shoals power down below.

More than likely the Commission will be obliged to have a public hearing, to bring some of these things out into the open and this is looked for soon.

The East Tennessee Development Co. is a subsidiary of the National Power & Light Co. It owns a half interest in the East Tennessee Development Co., the other half being owned by the Tennessee Electric Power Co. Tennesseans are hoping that some of these delays, largely political, will soon be cleared away so that the preliminary permits may be issued and power plant building go forward on a large scale. The proposed dams in question, with their expected production, are as follows:

On the Tennessee River at distances above Chattanooga: Sherman dam, 6 mi., 26 ft. high; Sale Creek dam, 30 mi., 25 ft. high; White Creek dam, 77 mi., 38 ft. high (Clinch River comes in here); Marble Bluff dam, 111 mi., 35 ft. high; Coulter Shoals dam, 142 mi., 53 ft. high.

On the Clinch River above its mouth: Senator dam, 6 mi., 39 ft. high; Melton Hill dam, 36 mi., 60 ft. high; Clinton dam, 68 mi., 20 ft. high; Cove Creek dam, 80 mi., 225 ft. high; War Ridge dam, 122 mi., 180 ft. high.

On the Powell River: Powell dam, 122 mi. above the mouth of the Clinch River, 160 ft. high.

On a 50-per cent load factor, the above-mentioned dams are expected by the designing engineers to produce 500,000 kw. or 670,000 hp. and in primary power are expected to produce 250,000 kw. or 335,000 hp.

Depending upon the foundations and the cost of the land, the engineers say that the building of these dams and power plants will cost between $60,000,000 and $100,000,000.

Melones Dam Dedicated November 11

MELONES DAM, joint property of the South San Joaquin Irrigation District, the Oakdale Irrigation District and the Pacific Gas & Electric Co., was formally dedicated with proper ceremonies on November 11, 1926. Approximately 5000 persons from all sections of the State attended the celebration. Among the speakers were P. H. Griffin of Modesto and John Hancock of Stockton, representing the two irrigation districts; Willington Creek, president of the Pacific Gas & Electric Co. and Irving Martin, Sr., president of The Stockton Chamber of Commerce and former president of the California Railroad Commission. Expenditure of $4,700,000 for the project represents a novel agreement between the irrigation districts and the power company and the project embodies practically all the ideas in water development heretofore advocated by Secretary of Commerce Herbert Hoover, who has suggested that the West make double use of its water resources.

New Station for Northern New Jersey

TO MEET power demands of a rapidly-growing industrial district, the Jersey Central Power & Light Co. is constructing a 20,000-kw. central station at Whippany, N. J. General estimates for the work place the completed cost at $3,000,000.

Because of the rail facilities with low freight rates on small-sized anthracite, this fuel will be used with storage facilities provided for 30,000 t. at the plant. The initial installation will consist of two 10,000-kw. Allis-Chalmers turbines and five 910-hp. Springfield boilers. Engineers of the General Engineering & Management Corp., designers and builders, preferred this equipment because of its element of reliability, rather than the slight economy, both in first cost and operation, that could have been effected by using a single 20,000-kw. turbine and three boilers. Wherever possible, the design calls for duplication of equipment.

A VIEW OF THE WHIPPANY PLANT JUST BEFORE COMPLETION OF THE STEEL WORK

Steam will be bled from the turbine at two points for feed water heating with a steam-driven hotwell and boiler feed pump provided for emergency and starting up.

Perhaps the most interesting part will be the electrical end where power generated at 600 v. will be taken by short leads to water-cooled transformers installed within the building. Outgoing power at 33,000 v. (later 66,000 v.) will be carried to the outdoor structure about 30 ft. from the main building, where the feeders for Morristown and Summit substations will be taken off. As one of the National Public Service Corporation's properties, the plant will be operated by the General Engineering & Management Corp.

Gage Cock Designed to Reduce Gage Glass Strains

IN THE ARTICLE under the above title on page 1239 of the Nov. 15, 1926, issue, we described a new type of gland used on its water gages by the O. C. Keckley Co., but referred to the part on which it was used as a gage cock. Although this part of a water gage is sometimes referred to as a gage cock, the latter term may cause confusion. Readers of this article, therefore, should substitute the words "water gage" for "gage cock."

Work Started on Diablo Project

WORK IS NOW UNDER WAY on the Diablo dam project of the Skagit River development now being carried on by the City of Seattle, Wash. The contract for the 4½-mi. extension of the construction railroad was awarded to Morris-Knutsen Co., Boise, Idaho, and it is expected that bids will be called for the structure about the middle of December. Final plans have not been approved but consideration is being given to the arch type concrete dam, since the preliminary design indicates about 275,000 cu. yd. of concrete. The estimated cost of the dam complete is to be about $3,000,000.

It is proposed to build this dam 880 ft. long and 365 ft. high with a storage reservoir back of the dam 4 mi. long having a capacity of 90,000 acre-feet. Two tunnels, each 20½ ft. inside diameter, will run 1700 ft. from the dam in Diablo Canyon to the power house at Reflector Bar. The latter will be designed for an ultimate capacity of 240,000 hp. The reinforced concrete power plant building will contain six generating units, 19 transformers and switching equipment. Vertical turbines to operate at 320 ft. head will be installed driving 3-phase, 60-cycle, 11,000-v. generators, each rated at 35,000 kv-a. Transformers raise the voltage from 11,000 to 165,000 for transmission.

Death of G. A. Sacchi

G. A. SACCHI, manager of stoker sales department, Westinghouse Elec. & Mfg. Co., died suddenly on November 4 at his residence in South Lansdowne avenue, Lansdowne, Pa. Mr. Sacchi virtually devoted his entire active life to the Westinghouse organization, becoming associated with the company in 1893 for Westinghouse, Church, Kerr & Co., which then represented the selling organization of the Westinghouse Machine Co. He was gradually promoted and for some time performed the duties of district engineer for the Westinghouse Machine Co. In 1909 he became engaged in the sale of stokers in the New York territory and later in the sale of large turbines as well. He was appointed district manager of stoker sales in the New York office in 1918 and subsequently manager of stoker sales for the entire company.

With the change in organization of this department in April, 1922, when the entire administration was moved to the South Philadelphia works, Mr. Sacchi was transferred there. In April, 1926, he was elected president of the Stoker Manufacturers' Association, which position he held at the time of his death.

Stone Becomes Manager Westinghouse Stoker Sales

E. R. STONE HAS been appointed Manager of Stoker Sales Department of the Westinghouse Electric and Manufacturing Company to succeed Mr. G. A. Sacchi, deceased. Mr. Stone has been affiliated with the Westinghouse organization practically from boyhood. Mr. Stone was born in Attica, N. Y., and attended the Attica public schools, graduating from the high school there in 1905. He became a Westinghouse employe in the fall of 1906 as draftsman at Attica.

In 1917 he took up sales work at East Pittsburgh Plant of the Westinghouse Company. Mr. Stone has devoted practically nineteen years to stoker work under the Westinghouse companies.

Charles S. Cook Dies

CHARLES S. COOK, vice-president and treasurer of the Kaestner & Hecht Elevator Co., died in Pittsburgh, Nov. 15. Mr. Cook, who was formerly associated with the Westinghouse Electric and Manufacturing Co. and the Duquesne Light Co., was widely known as an outstanding figure in electrical manufacturing and business circles. He had been identified with the electrical industry since 1887 and had been a conspicuous figure in the electric light and power field, street and urban railway development, as well as the electrification of steam railways.

Mr. Cook was a native of Amherst, Mass., and a graduate of Worcester Polytechnic Institute. He entered the employ of the Westinghouse Co. in 1887, and soon after became an erecting engineer. Later he was sent to the Chicago office and while there received an appointment as sales engineer. In 1892 he laid out and sold the first long-distance transmission system installed in the United States. This occurred at Pomona and San Bernardino, Cal., where a 28-mi., 10,000-v. system was installed. In the same year, Mr. Cook laid out the power system for the World's Columbian Exposition at Chicago.

In 1895 he was transferred to Pittsburgh to take up the application of electrical apparatus to steel mills. The subsequent large application of electric power to mills here is said to have been largely the result of Mr. Cook's work in that field.

He was made manager of the Westinghouse Pittsburgh office in 1899 and 5 yr. later, 1904, became manager of the Westinghouse Railway and Lighting department at East Pittsburgh. This position he held until 1917, when he resigned to become general manager of the Duquesne Light Co. Later he was made a vice-president of the company. In 1924, he affiliated himself with the Kaestner & Hecht Co., as vice-president and treasurer with headquarters in Chicago. He had come to Pittsburgh for medical attention at the time of his death.

News Notes

S. C. MILLER has joined the staff of the Ridgway Dynamo and Engine Co., Ridgway, Pa., a subsidiary of the Elliott Co. of Jeannette, Pa.

BOTFIELD REFRACTORIES CO. of Philadelphia, Pa., has appointed as distributors of its products the Curtis Supply Co., Inc., Washington St. at Perry, Buffalo, N. Y.; the Waldredh Supply Co., 707-711 Cherry St., Des Moines, Ia.; South Side Foundry & Machine Works, Charleston, W. Va.; Empire Machinery & Supply Corp., 409-411 Water St., Norfolk, Va.

THE EQUITABLE GAS CO., a subsidiary of the Philadelphia Co. and the Louisville Gas & Elec. Co., have recently made arrangements to secure gas for Pittsburgh and Louisville from a rapidly developing field of 600,000 acres in eastern Kentucky. A 20-in. pipe line approximately 165 mi. long will be laid to Burnsville from the field, the installation to cost about $5,500,000. Work will begin at once on compressing stations to be built in this new field capable of putting 40,000,000 cu. ft. of gas into Burnsville per day.

In honor of Charles R. Huntley, recently deceased, who was president of the Buffalo (N. Y.) General Electric Co. at the time of his death, the River Station of that company has been designated the Charles R. Huntley Plant. The station was started in 1916 as a result of Mr. Huntley's foresight. It will be completed with the final unit of 80,000 hp., soon to be finished, and will then be christened by appropriate ceremonies.

The Savannah River Electric Power Co., Savannah, Ga., a subsidiary of the Southeastern Power & Light Co., Birmingham, Ala., plans a hydro-electric plant on the Savannah River, about 21 mi. above August, S. C. The plant will have a generating capacity of 120,000 hp. in four units and a transmission system will be constructed to Atlanta, Macon, Charleston and vicinity.

W. C. Strunk, who has been in charge of stoker negotiation work at the South Philadelphia Works of the Westinghouse Company was recently appointed stoker specialist in the New York District succeeding E. R. Stone, who was recently promoted to Manager of Stoker Sales.

The National Hydro-Electric Co., Montreal, Quebec, has secured a concession from the Provincial Government for the construction and operation of a hydro-electric generating plant on the Ottawa River, Quebec. The plant will have an initial installation of about 375,000 hp.

The Associated Gas & Elec. Co., New York, plans to spend approximately $8,000,000 before the close of the year on immediate expansion and improvements of various properties. Included in this work will be the building of five new substations and extensions to the 132,000-v. transmission line to Niagara Falls, as well as additions in the 110,000-v. line in the Union City and Erie districts. The company has recently acquired an interest in the Staten Island Edison Corp. and will enlarge its capacity by the installation of a new 15,000-kw. turbo-generator with auxiliaries.

The Quaker City Cold Storage Co., Philadelphia, Pa., is making plans for a large increase in its present capacity by an addition to its present plant at Water and Spruce streets, consisting of a multi-story structure, with a total of 1,800,000 cu. ft. of space, estimated to cost $1,700,000 with equipment. The company will also lease for 25 years the cold storage and refrigerating division of the new freight terminal of the Philadelphia & Reading Ry. and the Baltimore & Ohio R. R. It will also take over and operate the plant of the Delaware Storage & Freezing Co. and will have all together a manufacturing capacity of 240 t. a day at the various plants.

According to recent data secured by the Bureau of Foreign and Domestic Commerce, Washington, D. C., there is a marked development in hydro-electric and steam power plants in various parts of the world. The Municipal Council, Loanda, Angola, is asking bids until Feb. 7 for a concession which provides for the construction and operation of a power plant and steam railway system. The Municipal Council at Sao Joao d'El Rei, Brazil, is asking bids for equipment for a proposed municipal hydro-electric power plant with an initial capacity of 4000 hp. to be later increased to 8000 hp. The Sociedade Anonyma Industrial Hulha Branca, Minas Geraes, Brazil, has had appropriated $225,000 for a hydro-electric plant at Curvello, Sete Lagoas, Bomfim and Diamantina, State of Minas Geraes. The French Chamber of Deputies, Paris, France, has authorized the building of a hydro-electric plant on the upper Rhine River, near Bale and Strasbourg, to have an initial capacity of 120,000 hp. The project will be carried out in connection with the development of the Rhine River for navigation purposes.

W. B. Flanders, of the large-turbine division of Westinghouse Electric and Manufacturing Co., has been appointed assistant manager of the engineering department.

D. W. R. Morgan, engineer of the condenser division of the same company, becomes manager of condenser and internal combustion engineering.

The Mexican Light & Power Co., Mexico City, Mex., is making extensive preparations for a great dam to be built across the Rio Lerma at Tepuxtepec, behind which will be stored 500,000,000 cu. meters of water for use in a great irrigation and hydro-electric power development. The hydro-electric project alone will cost about $8,000,000 and will involve the construction of a dam, tunnels, pipe lines and power plant, while the amount to be spent by the government on the irrigation system in connection with this project will amount to several millions of dollars.

Books and Catalogs

Heat Power Engineering—Part I, Thermodynamics and Prime Movers, by Barnard, Ellenwood and Hirshfeld, Third Edition, 480 pages, illustrated; New York, 1926; 6 by 9 in., cloth, $4.50.

Portions of the book dealing with elementary principles and their application to prime movers have been substantially rewritten to incorporate new material and methods of presentation. An important addition is the development of ideal cycles for engines and plants using reheating and regeneration which, it is believed, will give satisfactory standards on which to base the efficiencies of actual units.

The book is especially well adapted for classroom use, and, in fact, is planned as a one-year course in its subject, having illustrative practical examples for solution in connection with each chapter. Full study involves a working knowledge of mathematics through Calculus but much of the discussion, descriptions and conclusions can be profitably read without such knowledge.

Application of thermodynamic principles and laws is made to automobiles, oil and gas engines, steam plants, air compressors and refrigerating machinery. The general equation for energy, transfer and transformation is derived early in the book and is used as a basis for discussion of the action of machines which use gases and vapors as their medium, treating the cycles and processes from a "real mixture" standpoint.

Disregarding the fruitless search to get a physical significance for "entropy," the authors sanely treat it as a mathematical quantity which is found useful in engineering calculations and proceed to show how and why it is useful. The same common-sense treatment is adopted in regard to other matters; a discussion of what happens and what it is desired to know, then the application of mathematical tools to work out the prob-

lem and comparison of the standards thus developed with actual practice to determine the differences and their whyfor.

To the engineer who wishes to review his heat theory or to bring himself up to date, this book will be of greatest interest but must be approached with willingness to study and think. Such tables and charts as are needed are embodied in the book, making it a self-contained unit.

PROTECTING RESERVOIRS by Employment of Forest Cover is discussed in both its physical and financial aspects by W. W. Ashe of the Forest Service in Bulletin No. 1430 of the Department of Agriculture. Water storage is a recognized factor in hydro-electric development and problems arise from filling up of reservoirs with silt, thus reducing storage capacity, the amount of silt brought down depending on the erosion by the feeding streams. In one reservoir, half the capacity was lost within 10 yr.

Surfaces naked of vegetation are subject to heavy erosion and in some countries, where rainfall is irregular and concentrated the condition can be changed but little. In other locations, covering the surfaces with protective growth will be highly efficacious in reducing erosion. Where erosion cannot be reduced, Mr. Ashe suggests settling basins for the removal of silt which would also rehabilitate devastated land since the silt largely consists of the most fertile soil eroded from the watershed.

Mr. Ashe proposes a formula for determining how much can be economically expended to maintain the capital value of storage capacity which would be destroyed by siltage and shows that, in addition to the return that can be expected from lumber by reforestation of denuded areas, power and water companies are justified in making expenditure within the capitalized value of the storage capacity which will be preserved.

Copies of the bulletin can be obtained from the Forest Service, Washington, D. C.

THE A.S.H.V.E. GUIDE for 1926-7 has just been issued by the American Society of Heating and Ventilating Engineers. This is the fifth edition of this reference data book, and is one of the most complete ever published.

Several new chapters appear, and other sections have been amplified with much new material. For the first time, air conditioning, drying, mechanical plant ozone and building insulation have been treated thoroughly, and in addition new data has been given on greenhouse heating, water supply systems, boilers, oil burning and gas heating.

The result of further laboratory research has produced new tables on heating, humidity and air motion, as well as a new comfort chart.

This book has the same general appearance as the previous editions, being bound in blue cloth stamped in red and gold, and is 6 by 9 in. in size.

A new index to the technical data section is an added feature that will make the book more useful.

"THE NEW WAY OF MAKING STEAM" is described by the La Mont Corp., New York City, in its recent bulletin describing the La Mont waste heat steam generator. The principle of this generator is the injection of a small but over-sufficient amount of water into the top of a long ⅝-in. tube, heated by the hot gases, in such a way that the water strikes the sides of a tube and is held as a film to the interior of the thin heated metal wall, by adhesion of the water particles to the metal and cohesion of the water particles to each other. This creates a hollow center for the passage of the steam thrown from the film.

As only part of the water is turned into steam the remaining water, together with the steam formed, issues from the lower end of the tube and passes into a collecting pot; the steam is removed and the water returned to the top of the tube again. The generator has had application in gas-making plants and is entirely different in type from the average steam generator or boiler. It has been operated up to 125 lb. pressure but it is stated that it is suitable for much higher pressures. The statement is also made that it will be introduced into the power plant field in the near future.

KENNEDY-VAN SAUN MFG. & ENGRG. CORP., New York City, has just issued a 4-page folder describing Kennedy gyratory crushers for primary and secondary operations in capacities from 1500 t. to 2300 t. an hour.

O. C. KECKLEY CO., Chicago, Ill., has just issued a bulletin describing its complete line of water gage specialties. These include the Keckley water gage with patented stuffing box, gland and swing bolts, various types of water columns, gage glass shields, illuminators and other water column accessories.

INGERSOLL-RAND CO., New York City, has issued a new and revised addition to its bulletin describing Cameron single-stage, double-suction, volute pumps, class LV, FV and HV. Many photographs of installations are shown, together with illustrations of the parts of the equipment and discussion of its principal characteristics. These pumps are designed for great strength and simplicity, as well as high efficiency, and each pump is given a running test duplicating field conditions, except for the handling of liquids other than water.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, INC., 285 Madison avenue, New York City, has just issued a handbook containing allowable load tables for use in designing steel structures intended for the use of engineers and architects. The tables are based on 18,000 lb. per sq. in. stress on extreme fibers of rolled shapes in bending and a maximum 15,000-lb. fiber stress in columns reduced by formula. Tables of allowable loads for beams and columns include all of the data for each structural shape and each type of plain and built-up columns. This is designed to obviate the necessity of referring to different tables.

BUFFALO FORGE CO., Buffalo, N. Y., in its new bulletin No. 466, describes Buffalo unit heaters, illustrating various types and applications. The Buffalo heater discussed in detail has a heating surface of copper-finned, brass tube coil combined with a Buffalo Breezo fan of the multi-blade propeller type. It is made in units from $\frac{1}{10}$ hp. and furnishing 1625 c.f.m. to units furnishing 8200 c.f.m. requiring a 1-hp. motor. The new Buffalo high-pressure units employ an improved type of Conoidal fan and coils of ½-in. standard steel piping good for 150 lb. pressure. These are designed to be placed on the floor in most cases, whereas the Breezo-Fin heaters can be supported on the walls or in any convenient location.

Tearing out stony scale *is no job for a featherduster*

Soft words may turn away wrath—but it takes something with teeth in it to turn away scale — teeth backed up by power, stamina, durability under grindingly tough service.

All of these virtues are held by Liberty Cleaners. There is soft scale and hard scale—but the hardest variety only makes the Liberty grit its teeth and bore in harder.

There is a size and type of Liberty Cleaner to fit your tubes.

LIBERTY MANUFACTURING COMPANY, Jeannette, Pa.

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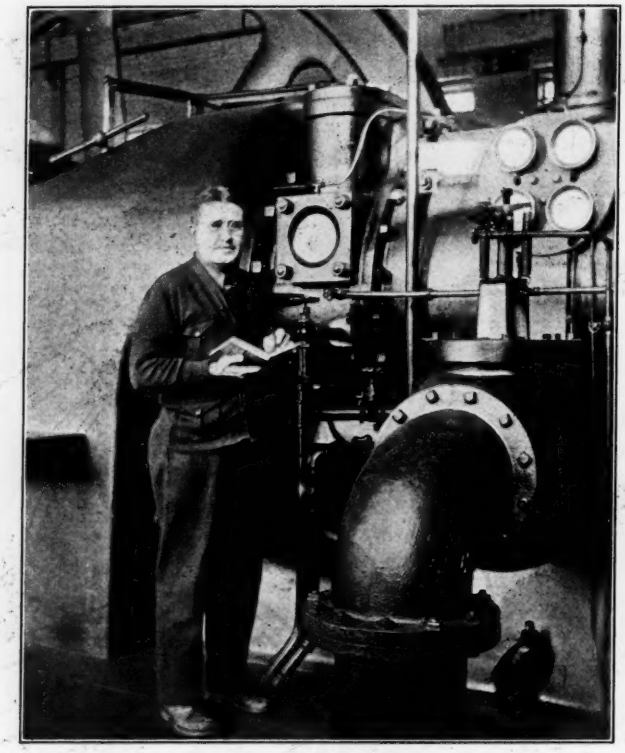


Mr. L. M. Johnson, a winner in the recent "U.S." Rainbow Old-Timers Contest, and an enthusiastic user of "U.S." Rainbow for over a quarter of a century.

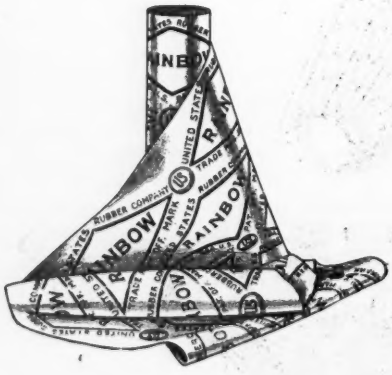
"For 26 Years I Have Relied on "U.S." Rainbow Packing"

For over a quarter of a century Chief Engineer L. M. Johnson of Sewickly, Pa., has been satisfactorily solving packing troubles with famous "U.S." Rainbow Red Sheet. Here's what Mr. Johnson said about "U.S." Rainbow in a recent letter.

"During my 26 years of engineering experience I have applied 'U.S.' Rainbow to all kinds of pipe connections, boiler manholes, hand holes, air, steam and ammonia cylinder heads. Always if I had a difficult joint to hold it was Rainbow I relied upon. It has never disappointed me."

"U.S." Rainbow is the original red sheet packing. First made in 1889, it was known then, as it is today, as the best all-round sheet packing. When you buy sheet packing—specify "U.S." Rainbow. Nothing equals this old standby. Use it for steam pressures up to 170 pounds, for air, hot or cold water, and all hydraulic conditions. It will reduce to a minimum the amount of sheet packing you have to buy and keep in stock.

On your next packing order don't say "red sheet," insist on getting genuine "U.S." Rainbow.



Genuine "U.S." Rainbow Sheet Packing is made only by the United States Rubber Company. It can be identified by the name "Rainbow" in the diamond and the "U.S." in the circle, stenciled in rows running the length of the roll.

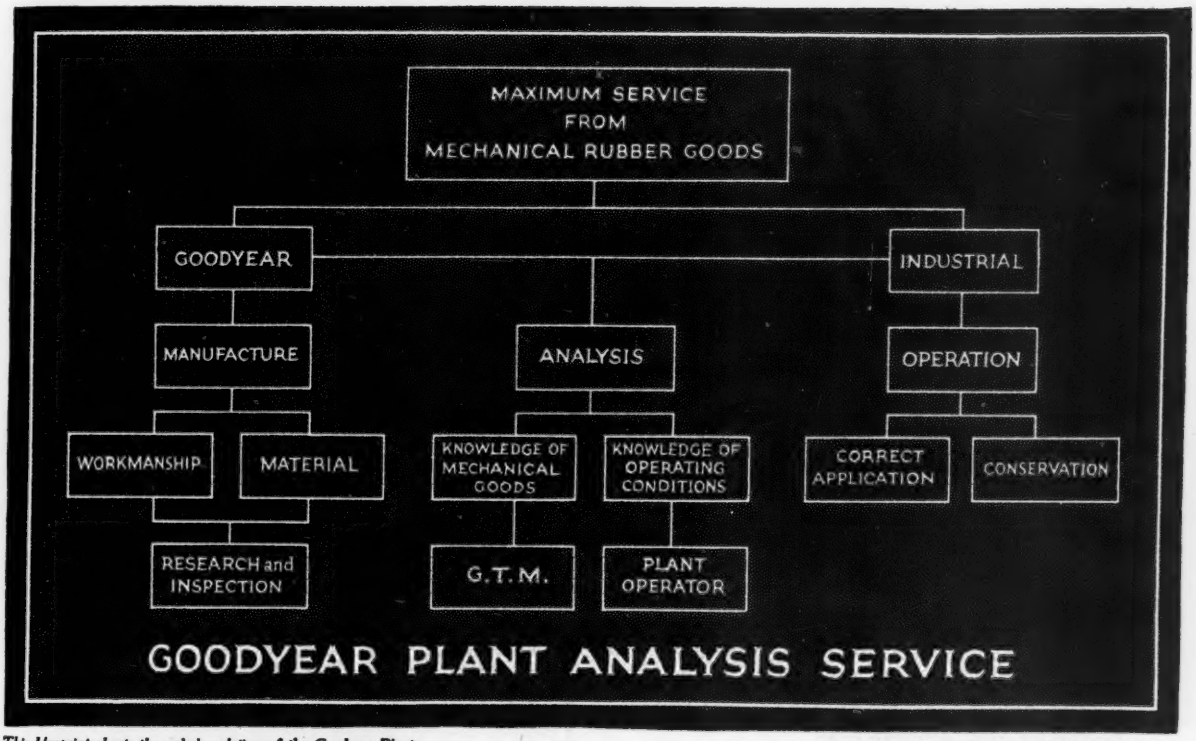
United States Rubber Company

1790 Broadway **New York City**

Branches in every industrial center

Trade Mark

"U.S." RAINBOW PACKING



This blueprint charts the orderly relation of the Goodyear Plant Analysis Plan for maximum service from mechanical rubber goods

Copyright 1926, by The Goodyear Tire & Rubber Co., Inc

The Plant Analysis Plan—and the G. T. M.

The entire purpose of the Goodyear Plant Analysis Plan is to provide for industry the most efficient and economical of mechanical rubber goods—belts, hose, valves and packing. It offers a sincere and scientific service, which embodies expert study of requirements, experienced manufacture of products, and an unfailing interest in the performance of the product on the job.

Two important factors in the successful operation of this Plan are entrusted to the G. T. M. — Goodyear Technical Man. He makes the original study of plant requirements, and he keeps in touch with the product performance, suggesting ways of increasing its utility and prolonging its serviceable life.

The G. T. M. does his work on the basis of expert knowledge applied to the actual plant conditions. He brings to his task a scientific grounding in the properties of mechanical rubber goods and a wide experience in the operating conditions of leading industries. He places this equipment at the service of the plant superintendent or factory engineer.

In co-operation with the plant officials he makes a careful survey of all the mechanical factors involved. Makes accurate measurements of pulley dimensions, center-to-center distances, speeds and loads.

What the G. T. M. does, therefore, is to substitute science for guesswork, and replace "a belt" or "just belts" with "the right belt for the job."

Along with his specification goes the work of the Goodyear Development and Production departments. Here, the G. T. M.'s calculations are checked over carefully. Here, the qualities that he orders are built into Goodyear Mechanical Rubber Goods with all the knowledge and skill of long experience and continued striving for perfection.

A staff of research and development engineers is constantly engaged in the study and testing of superior materials for Goodyear Mechanical Rubber Goods. The only fabrics and compounds they are interested in are those that give promise of longer life and better results. Consequently, the Goodyear product measures up to Goodyear specification for uniformity, quality and maximum strength.

And then the factor of Conservation: The Goodyear Analysis Plan, operating through the G. T. M., endeavors sincerely to see that the product thus accurately specified and properly built yields to its user the very utmost in long-lived, trouble-free economical service.

These are the reasons why you may find it profitable to employ the Goodyear Plant Analysis Plan in your plant. The G. T. M. will be glad to make a study of your operating problems, and will recommend the best products for your use. For further information about the Plant Analysis Plan and the records of Goodyear Mechanical Rubber Goods in your particular industry, write to Goodyear, Akron, Ohio, or Los Angeles, California.

Goodyear Means Good Wear

VALVES · PACKING BELTS · HOSE

GOODYEAR

"My Ammonia loss less than 1 per cent in 12 months."

A Higher Standard of Packing Service

TROUBLE has been too long associated with packings in the minds of engineers, especially in these days of modern high pressures. In the glands and stuffing-boxes of valves and rods on Diesel, Oil and Turbine Engines; Compressors on Air and Ammonia Service and on Condenser Tubes, you can end all packing troubles with

Ambest TRADE MARK

Flexible Metallic Packing

EVERY rod and stem that is true and in line should be packed with Ambest. Will not fuse, up to 600 deg. F. Cannot scratch or cause distortion.

No matter how severe the service, you can depend on Ambest packing to maintain leak-proof, frictionless service for many months and even years.

Long, straight strands make any size packing all out of the same can. No tangled mass.

Draws down to a smooth, even fit around the valve stem or rod. Doesn't wear or harden. At most you will only need to add a little Ambest to the original packing as time goes on.

EUREKA PACKING COMPANY
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Send for FREE trial sample —no obligation

CRANDALL insures gaskets that give enduring *service*

ALL KINDS of PACKING for ALL KINDS of CONDITIONS

the mark of 35 years' service in making better packing

Gaskets that are up to the standards of Crandall Packings must give MORE than ordinary service, and that's the kind of gaskets we make. TRY them and see for yourself!

Style No. 75 is a good one to start with. It holds on ANY boiler pressure. Our own formula of rubber cement and the finest asbestos cloth makes this gasket impossible of duplication. Write

CRANDALL PACKING CO., Palmyra, N. Y.
O. J. Garlock, President and General Manager
This Company is not affiliated with any other packing concern selling the customer.

Bearing metal *plus service*

ORDINARY bearing metals may look quite similar to Magnolia Metal, weigh the same, and cost even a trifle less. But when you buy Magnolia Metal, you get the assurance of long and efficient service as well as just so much metal. U. S. and foreign government tests have proven Magnolia Metal to have the lowest frictional coefficient of any known bearing metal and to have every other requirement for its purpose besides. Magnolia Metal melts and pours well, is easily peened and scraped in, and is always uniform in composition. Try Magnolia Metal on one of your bearings and test its superiority to your own satisfaction.

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Chicago Arlington Hts. | San Francisco 358-360 Bryant St. | Montreal 396 St. James Ct.

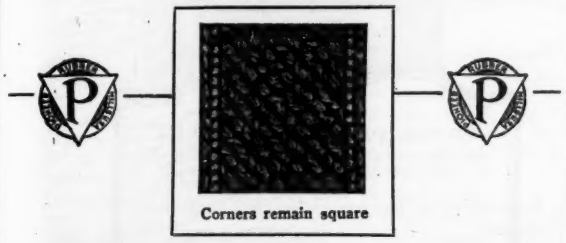
MAGNOLIA ANTI-FRICTION METAL TRADE MARK

In the metal line, specify Magnolia Products.

Power Costs Money
Don't Waste It

THE use of ordinary piston rod packing, with its inefficient service and short life, means loss of power—extra repackings for the engineer—frequent shut-downs.

Use



SKOOKUM

(Sold in Canada as Spando)

Cross Expansion Piston Rod Packing

Skookum prevents the loss of power.
Skookum is long-lived.
Skookum saves the engineer work by lessening the number of repackings.
Skookum prevents costly shut-downs.
Skookum never rolls with the action of the piston rod.
Skookum has layers of duck and rubber on two sides (our patent). These hold all the diagonal layers in place at all times—prevent the corners breaking off and enable Skookum to retain its rectangular shape until worn out.

Try Skookum Free

If you have never used Skookum we will send you, free, enough to pack your engine or pump.

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Manufacturer and Patentee
345-353 Sacramento Street, San Francisco, Cal.
One of the Largest Manufacturers of Garden Hose in the World
Plant: Pittsburg, Calif.
Sales Offices in all Principal Cities

Don't Repack So Often

The average packing does not stand up under high pressure, super-heated steam, because it contains materials that are soon destroyed by the high temperatures.

TRADE MARK
"PALMETTO" PACKING
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is designed especially to withstand the destroying tendencies of high temperatures.

Its materials are entirely heat-resisting and its perfect single strand lubrication keeps it soft and pliable in service.

Braided—for rods.
Twist—for valves.

Why not let us send you free working samples to prove greater economy of "Palmetto?"

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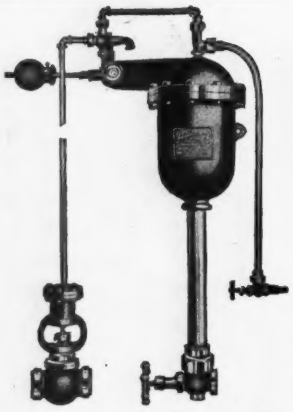
Sole Manufacturers
109 Duane St., New York



O. K.

The experienced power plant engineer knows that a constant water level in boilers is essential if the plant is to be run economically.

So he puts his O.K. on

VIGILANT

Feed Water Regulators

They eliminate careless hand feeding and assure a constant water level. Boiler strain is reduced, steam production is increased and fuel economy is secured.

Play safe with a Vigilant.

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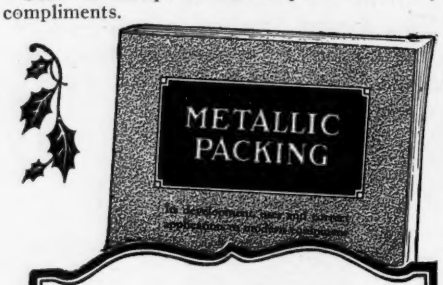

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This remarkable regulator was announced and thoroughly discussed in the June 15th number of Power Plant Engineering.

Any engineer can install the Campbell himself and be assured of POSITIVE regulation.

No floats. No links. No thermostats. No generators. Nothing to get out of order.

You can be absolutely certain that the water level will be maintained right where you want it all the time.

Bulletin on request.

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REGULATING VALVES FOR EVERY SERVICE

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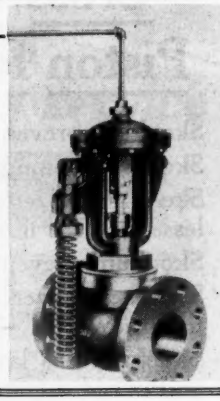

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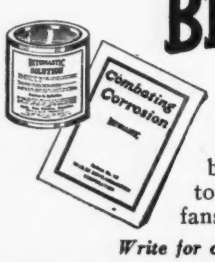

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COMPLETE PACKING INFORMATION

An MA-1925 catalog, describing Garlock Mechanical Packing Service, should be in the hands of every person having supervision over any type of mechanical equipment.

Write Us and Obtain a Copy

THE GARLOCK PACKING COMPANY

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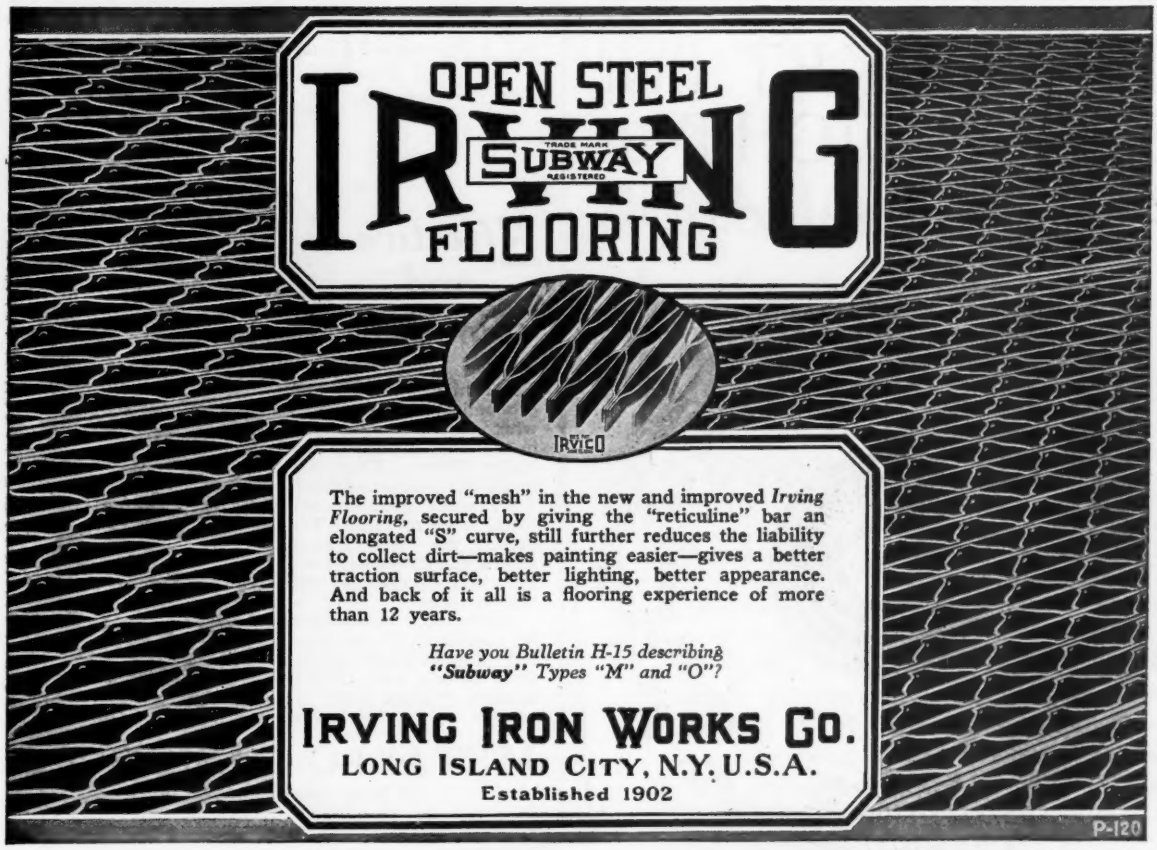
PALMYRA, N.Y.

The Standard Packing of the World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The improved "mesh" in the new and improved *Irving Flooring*, secured by giving the "reticuline" bar an elongated "S" curve, still further reduces the liability to collect dirt—makes painting easier—gives a better traction surface, better lighting, better appearance. And back of it all is a flooring experience of more than 12 years.
Have you Bulletin H-15 describing "Subway" Types "M" and "O"?
IRVING IRON WORKS CO.
LONG ISLAND CITY, N.Y. U.S.A.
Established 1902
P-120

Holmes Packings

for

Steam, Air and Gas

Satisfaction Guaranteed

SPLIT CASE, ETC.

23 Patents. Beware of Infringers

Holmes Metallic Packing Co.

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Conneaut Plastic Metallic Packing

is formed with the fingers to fit stuffing-boxes of any shape or size.

It forms to the rod or stem a smooth metal surface.

An adjustable metal packing that does not wear, score or pit.

Put up in five and ten pound cans.

Send for Descriptive Literature

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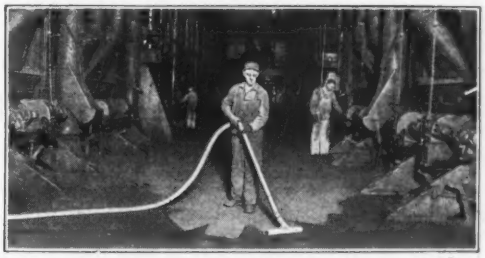

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Not many things are both economical and necessary as is the

ABCO System of Cleaning

It keeps power plants and industrial plants dustless and so pays dividends in labor, time and wear on machinery saved; reduces fire risks and also is necessary to prevent serious risk of dust explosions.

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Pneumatic Engineers and Manufacturers

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The GASKET that STAYS TIGHT at

2000° F. 1470 lb.

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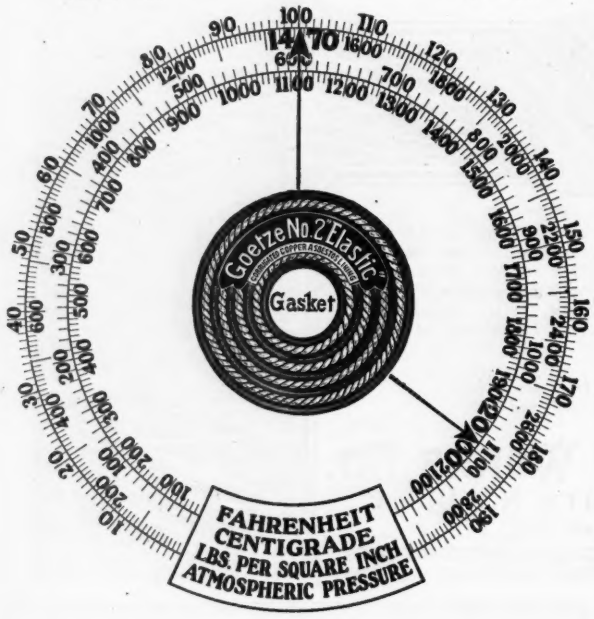

Goetze No. 2 Elastic

Corrugated Metal Gaskets with Asbestos Lining

The handy interconversion chart shown above may be useful to you. The hands show why Goetze No. 2 Gaskets are setting new records on high temperature and high pressure service.

Metal and Asbestos shaped into alternate walls that seal easily against the flanges with little pressure is the Goetze construction that insures long, dependable service.

For more than 20 years power plants have found these resilient, compressible walls of asbestos and copper the reliable protection against leaks and fuel waste.

Goetze No. 2 Elastic Gaskets make a close fit even on rough flanges and stay tight for the life of several ordinary gaskets. And they may be used over and over again.

Made in all sizes and economical on any temperature and pressure service.

You may try a Goetze Gasket for 90 days free. Write today, stating size you wish to try. There's no cost nor obligation.

The new 42-page Goetze Guide shows gaskets and packings for all services. Sent free on request.

GOETZE GASKET & PACKING CO.

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Sectional View of Metallo Gasket

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Dependable, enduring and economical service—that's what you get when you install Metallo Gaskets and Valve Discs. They are made for all conditions. They make good in any plant, large or small. Try them on your most severe conditions of modern high pressures and temperatures.

Interesting information is contained in our new free Metallo Book No. 26. Free 90-day trial of any Metallo Product given on request.

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Gaskets and Discs

METALLO GASKET CO.

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In Severe Cases

try "Flexitallic" Gaskets free of charge and find out how completely they end troubles.

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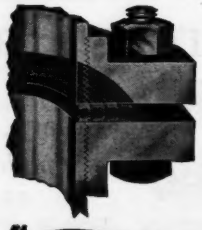

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FREE TRIAL OFFER

IDEAL is the original manufactured commutator resurfacer. Since 1915 IDEAL has grown from 45 customers to over 13,000 who standardize on IDEALS and use them periodically in the maintenance of commutators and slip rings. Over 500,000 used.

IDEAL assures: Fastest cutting
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Ideal Commutator Dresser Co., 1033 Park Ave., Sycamore, Ill.

Gentlemen: Please send me details of your free trial offer.

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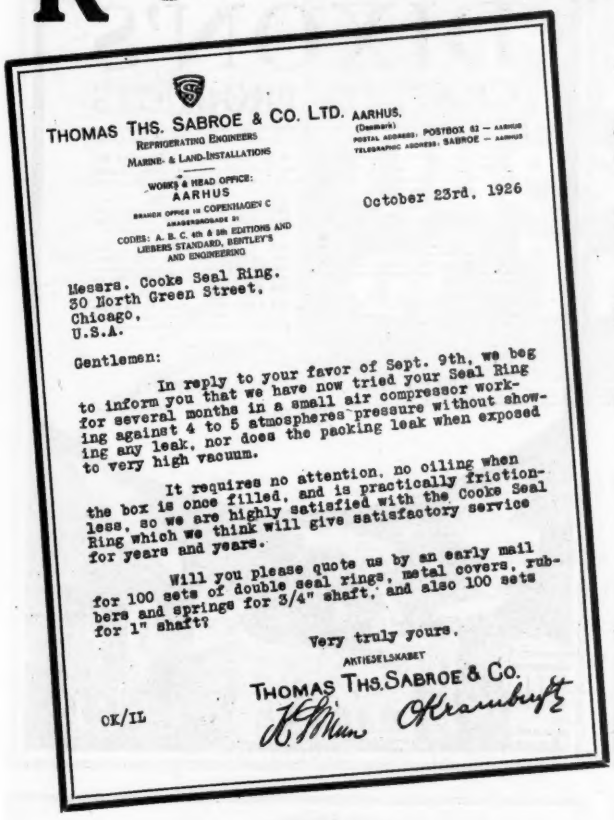
Address .....

City .....State.....

"Requires no attention except oiling and is practically frictionless"—

that's why repeat orders roll in from all over the world!



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October 23rd, 1926

Messrs. Cooke Seal Ring.
30 North Green Street,
Chicago,
U.S.A.

Gentlemen:

In reply to your favor of Sept. 9th, we beg to inform you that we have now tried your Seal Ring for several months in a small air compressor working against 4 to 5 atmospheres pressure without showing any leak, nor does the packing leak when exposed to very high vacuum.

It requires no attention, no oiling when the box is once filled, and is practically frictionless, so we are highly satisfied with the Cooke Seal Ring which we think will give satisfactory service for years and years.

Will you please quote us by an early mail for 100 sets of double seal rings, metal covers, rubbers and springs for 3/4" shaft, and also 100 sets for 1" shaft?

Very truly yours.
AKTIESELSKABET
THOMAS THS. SABROE & Co.

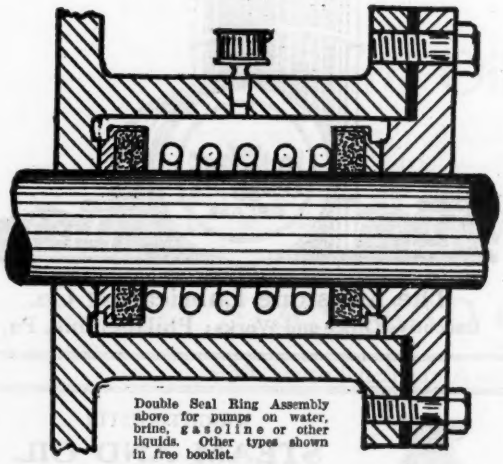
CK/IL

READ the words from DENMARK—of one of the hundreds of users of Cooke Seal Rings in the letter at the left—how would you like such service as this on large and small rotary, centrifugal and vacuum pumps, compressors, refrigerating machines, etc.?

You can have it, too, without one cent of risk because we will furnish a Cooke Seal Ring assembly for any machine that has a rotary shaft and for any service—water, air, gases, acids, etc.—for 60 days' free trial.

Cooke Seal Rings are earning their way in plants all over the world. Once tried, there is such a great saving in power, leaks, trouble and shut downs that they are ordered and reordered again.

Write for booklet now. From it select the assembly for the service you wish to try. Don't put off the savings Cooke Seal Rings are effecting in other plants—and are bound to effect in your plant.



Double Seal Ring Assembly above for pumps on water, brine, gasoline or other liquids. Other types shown in free booklet.

Strictly a Mechanical Device

that ends the use of packing is the Cooke Seal Ring, view of which is shown at right of signature and which is the secret of Cooke Seal Ring Assemblies.

COOKE SEAL RING

(Geo. J. Cooke, President Cooke Cold Storage Co., Inventor and Sole Manufacturer, personally guarantees complete satisfaction.)

28 N. Green St., Chicago, Illinois

Personally Guaranteed by

Geo J Cooke

Inventor

COOKE SEAL RING

"Ends Stuffing Box Troubles on Rotating Shafts"

"Ohio" Products

Cylinder Grease
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Chain Grease
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Gear Shield
Wool Elastic Grease
Wool Yarn Grease
Wool Waste Grease
Block Grease
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Industrial Lubricants of Superior Merit

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Ask about our spare time Agency Proposition.

It won't interfere with your regular work.

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The best graphite procurable—the right graphite for each particular purpose—scientific manufacturing methods—these are the open secret of Dixon superiority

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Dixon's Graphite Cup Grease. The best quality mineral oils correctly proportioned with lubricating flake graphite. It has the property of flowing into the bearing as soon as the shaft begins to turn, instead of remaining stiff in the cup till the bearing heats and softens it. Produces dead smooth, graphited bearing surfaces—insures cool running engine, motor shaft and other bearings.

Dixon's Ticonderoga Flake Graphite Ideal for cylinder and bearing lubrication, for coating gaskets, and for any other purpose where a superior graphite is desired.

Dixon's Solid Belt Dressing. A product that keeps leather belts pliable and decidedly lengthens belt life. Stops slipping instantly.

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We publish an interesting booklet of over 50 pages, illustrated, containing much of value to you men of the power world. Would you like a copy? Ask for Book 96-XP

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Jersey City, N. J Established 1827

ALBANY GREASE

For Dependable Lubrication

Power plant machinery functions better when lubricated with Albany Grease. Sold in cans and barrels—all consistencies. Never drips.

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Your dealer can supply you. If not, write us.

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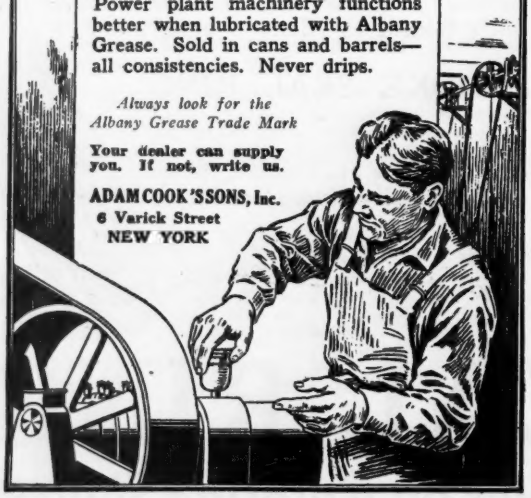

The Keystone Lubricating Co.
Executive Office and Works: Philadelphia, Pa.

Type "A" Steam Separator

WRIGHT-AUSTIN
STEAM AND OIL SEPARATORS

Cast in one piece, self-cleaning, requiring no maintenance. Complete line of all sizes and types.

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Type "S" Oil Separator
(229)

The Question of Trade

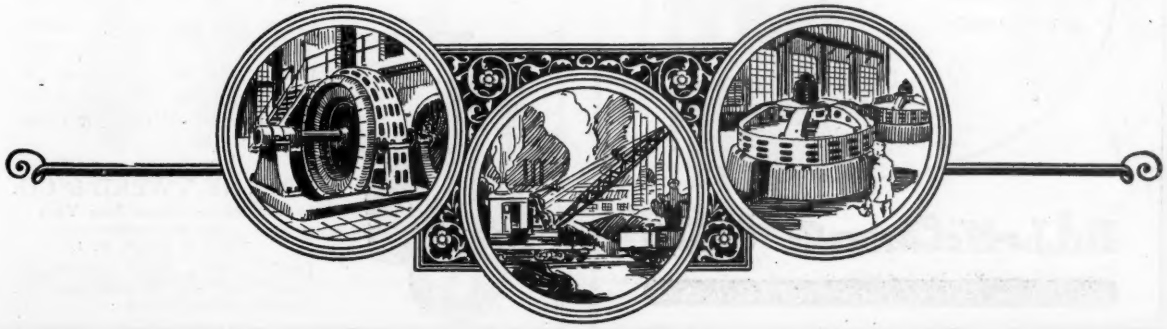
IN SELECTING oils and greases for your machinery, care should be taken to choose those which are best suited to the machinery in your plant. Lubricants should be selected according to the work they will have to do and the wear they will have to endure, just as the manufacturer of a machine uses steel in one place, cast iron in another and bronze in still another.

Lubricants should not be chosen from the standpoint of viscosity alone. The suitability of the oil or grease to the running speed of the machine, the bearing preassure, and the heat under which the machine operates must also be considered. In some cases, where the lubricants are exposed to acid or salt water, special care must be taken to select oils or greases which will resist the action of these agents.

Standard Oils and Greases

are made in a wide variety of grades to meet the requirements of all machinery now used in the industrial world. For your own protection, it is advisable for you to have the aid of the Standard Oil Company (Indiana) representative, who is competent to tell you which grades will give the best results under the conditions present in your plant.

STANDARD OIL COMPANY
(INDIANA)
930 South Michigan Avenue Chicago, Illinois



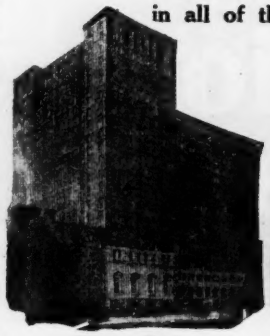
"HUMAN"

NUGENT FILTERS

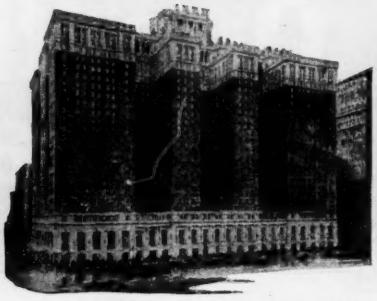
OIL

Oiling Systems, Telescopic Oilers and Devices in all of these Hotels and Club in Chicago

Ill. Women's Athletic Club (Largest in the World)



Sherman Hotel (1700 Rooms)



Steven's Hotel (3,000 Rooms) (Largest in the World)

Palmer Hotel (2268 Rooms)

WONDER WHY THEY ALL PICKED THE NUGENT

Ask the chief or consulting engineer or write to our nearest branch.

Lubricating Engineers and Manufacturers of Oil Filters, Oiling Systems, Oil Filtering Systems, Oiling Devices, Telescopic Oilers, Compression Pipe Fittings (no threads).

Bismarck Hotel (1600 Rooms)

WM. W. NUGENT & CO., Inc., 411 N. Hermitage Ave., Chicago, Ill., U. S. A.

Established 1897

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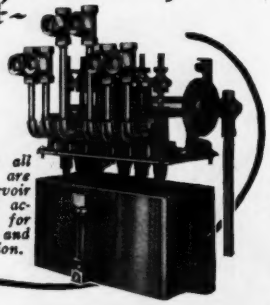
Individual adjustment on each plunger of Hills McCanna Lubricators permits oiling a number of bearings on one machine or on several machines economically and positively from a centrally controlled unit—

Let us solve your application problems—



Showing how all working parts are built above reservoir where they are accessible for adjustment and regulation.

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First in the Field of Force-Feed Lubrication

The "Manzel" Oil Pump is Positive and Exact

Starts and stops with the machine it lubricates. The rate of feed is automatically adjusted to meet the engine's need at any speed.

The "Manzel" Oil Pump provides ideal lubrication for all types of engines, pumps, air compressors, etc.

Made with one or more feeds, ratchet or rotary drive.

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30 Days' Free Trial

ROCHESTER LUBRICATORS

Rotary Drive Rochester Lubricator

feed oil on compressors, engines and pumps on steam, ammonia or air service with practically no attention except refilling. Effect great oil savings. Write for Catalogue "T."

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"It's the Best Bundy Trap yet"

THAT'S what users say of the New Bundy Steam Trap. It's a boiler return trap that fills every demand of even the most modern high pressure operation.

It has 36 years of experience in solving steam trap problems back of it and also the Bundy reputation for anticipation of steam trap needs.

This trap has retained all of its time-tested features and added these valuable new ones:

Simplified—Bowl, Pipes and Elbows cast in one piece—four parts saved and screwed joints eliminated.

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Positive—Ball-bearing Lever still further insures its smooth perfection of operation, and certain tilting action.

Easily Adjusted—Valve Stem Attachment with no rigid connections, set screws or check nuts is another highly appreciated feature.

Steam Tight—No packing troubles because of the ground joints and liquid coupling.

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The Mark of Trapping Service

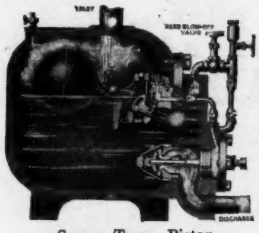
New Bundy Boiler Return Trap—a Coal Consumption Reducer

Write for free new Bundy Book

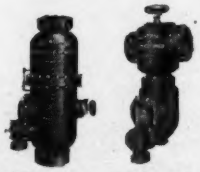
BUNDY Steam Traps
for every service

NICHOLSON *Steam Specialties*

offer coast-to-coast service for your convenience



Super Trap, Piston-Operated



Vertical Combined Separator and Trap — Horizontal Separator and Trap

MARK YOUR MAN ON THE LIST BELOW!

The nearest Nicholson man is ready to assist you immediately with the exact steam specialty that best meets your conditions.

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"Nicholson" Welded Steel Float for steam pressures to 1000 lb.

The complete line of Nicholson Specialties, adaptable to a wide range of special service conditions, is fully described in the 32-page Nicholson Book. Write for a copy.

"Nicholson" Expansion-Steam Trap

W. H. Nicholson & Co.
120 Oregon St., Wilkes-Barre, Pa.

These traps are trouble-free

Steam traps are remembered to the extent that they can be forgotten.

That accounts for the large percentage of Armstrong repeat customers. Their first Armstrong was conspicuous for its complete lack of trouble—no wire drawing and valve scoring, no air binding, no steam waste, no clogging.

The patented principle of the Armstrong—the inverted submerged bucket principle is responsible for its extreme simplicity, its small convenient size, its moderate first cost and freedom from repairs.

Let us send you a complete catalog

90 day trial!

If you don't know the Armstrong, you should. To convince you of its superiority we will send you a trap for a 90-day trial. We'll send it prepaid and you can return it collect. No expense. No obligation. See conditions on the coupon opposite.

You can see a glass model of the Armstrong working on steam in Booths 403 and 404 at Chicago.

Use the Coupon!

Please ship prepaid an Armstrong for 90-day test. It is understood that when the test is completed the trap is to be returned collect.

Trap capacity_____ Size of pipe connections_____

Steam pressure_____ (Do not neglect to state maximum).

Firm _____

Address _____

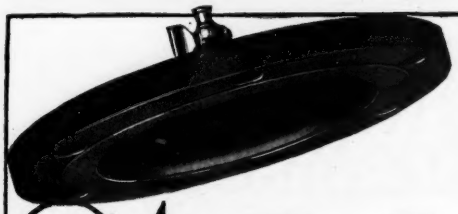
_____

Signed_____ Position_____

Mail to ARMSTRONG MACHINE WORKS
310 Maple Street, Three Rivers, Michigan

Armstrong Steam Trap

PPE 12-15 Gray



the steam trap with one moving part

AND this moving part *never* needs adjustment. The Johns-Manville Steam Trap has nothing that can get out of order or that requires periodic attention. Its action is as simple as its design. Install a few of "the simplest steam traps made" and cut the loss on your steam lines—and maintenance charges, too.

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292 Madison Ave., at 41st Street, New York City
Branches in all large cities
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JOHNS-MANVILLE
Steam Trap

A Message to Manufacturers of Steam-Using Equipment

To Manufacturers of

Turbines	**Steam Meters**	**Valves**
Engines	**Superheaters**	**Fittings**
Pumps	**Engine Stops**	**Traps**
Compressors	**Regulators**	**Packing**

When you guarantee your product, make your guarantee contingent upon the use of Steam that conforms to Standard Specifications (which is free from boiler water or dust).

Then you will have the advantage of working under definite, controlled conditions; all uncertainty will be banished.

The use of Standard Specification Steam means entire immunity from all the erosion, fouling, and clogging commonly met with in plants using "commercially" dry, or uncleaned Steam. Standard Steam, only, will permit your product to function exactly as contemplated by your designers.

The saving to the USERS of your apparatus will in a few short months repay the cost of making the change to Standard Specification Steam. The advantage to YOU is obvious.

Send the coupon for a copy of The Standard Specifications for Clean and Dry Steam

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The TRACYFIER

Assures the Continuous Delivery of Standard Specification Steam

See Our Exhibit

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Chicago Power
Show

Andrews-Bradshaw Co., 531 Fourth Ave., Pittsburgh, Pa.
Please send a copy of "Standard Specifications for Clean and Dry Steam."

Name of company.....

Name of individual.....(Title)

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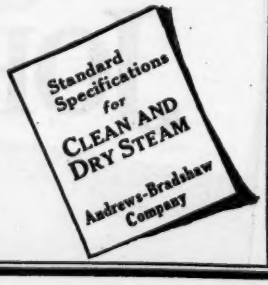


Saved $7500.00 per month

It was costing a large manufacturer an average of $22,500.00 a month for coal. One of our Engineers was called in to make a survey. He found here and there a large steam trap, while some steam lines where condensation collected were without any traps.

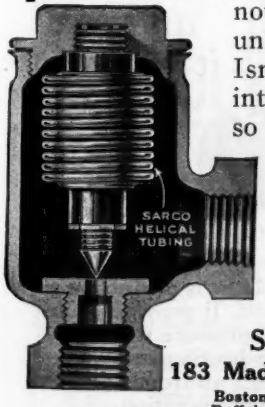
On our recommendation, all the inefficient old traps were scrapped and 257 Sarco Steam Traps installed. The result was a coal saving amounting to $7,500.00 a month.

The coal the Sarco Steam Traps saved paid for the traps in seven days.

This is a shining example of the huge savings constantly being made by trapping steam lines with the Sarco. Even in small plants almost unbelievable savings are frequently effected.

How do you know that you could not effect big savings unless you investigate? Isn't it worth looking into, when you can do so without cost or obligation?

Write us to have one of our Engineers call; or simply mail the coupon.



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183 Madison Ave., New York City

Boston Chicago Detroit
Buffalo Cleveland Philadelphia

Peacock Bros., Ltd., Montreal

SARCO STEAM TRAP

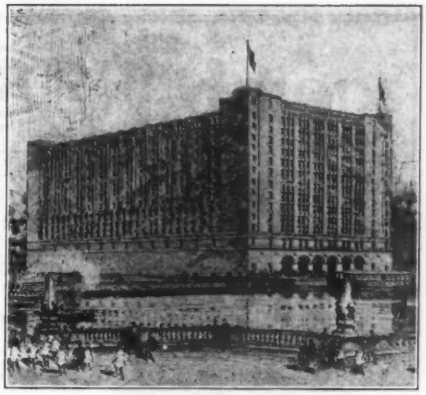
SARCO CO., INC.,
183 Madison Ave., New York.

☐Please have one of your Engineers examine the trapping conditions in our plant and make recommendations without any cost to us.
☐Send Booklet No. B-281.

Firm .....

Address .....

City ..... State.....



Office and warehouse of Hibbard, Spencer, Bartlett & Co., Chicago; Graham, Anderson, Probst & White, Architects; Mehring & Hanson, Contractors; in which A-Jacks Damper Regulator was specified.

A Review of the Year shows leading plants use A-JACKS Damper Regulators

We can tell but little of the story of the service A-Jacks Damper Regulators are giving in the progressive plants of the country.

Here are a few of the advantages of the A-Jacks which have won orders and re-orders from all parts of the country:

Maintains automatic control of position of damper within 1-lb. variation in steam pressure; insures graduated action—which is adjustable to meet any range of operating conditions; requires no auxiliary water supply—direct steam operation; with the National Balanced Control Valve gives dependable, graduated control of stoker and fan engines; eliminates human attention. Pays for itself in a few weeks in fuel saved.

Orders and repeat orders are proof of the leadership of A-Jacks Damper Regulators. Further information on request.

National Regulator Co., 2301 Knox Ave., Chicago, Ill.

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Federal Reserve Bank Bldg.
Drake Hotel.
Peoples Gas Bldg., Chicago.
Straus Bldg.
Marshall Field & Co. Bldg.
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Exide Batteries
Continental Bolt & Nut Co.
Fisher Body Co.
Continental Can Co.
American Smelting & Refining Co.
Standard Oil Co.
Coca Cola Co.
Elgin Watch Co.
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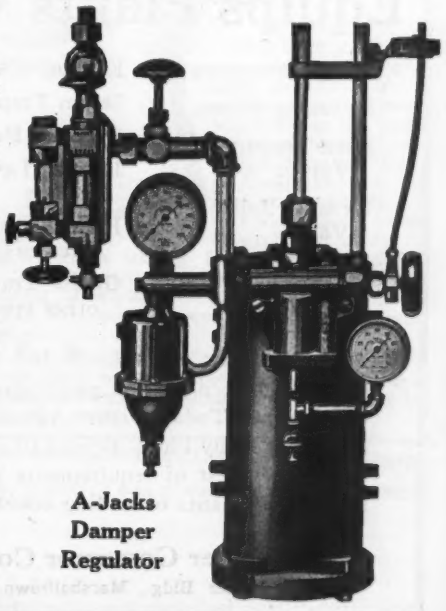
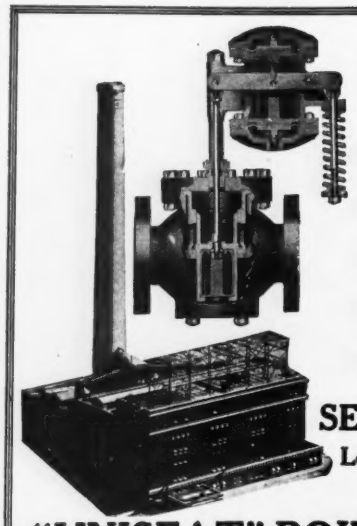
Western Electric Co.



A-Jacks Damper Regulator



R-K
TRADE MARK REG.U.S.PAT.OFFICE

the Trade Mark back of many devices used in notable plants such as

SEAL BEACH
Los Angeles, Cal.

"UNISEAT" BOILER FEED PUMP GOVERNOR

is one of the "R-K" Regulating Devices that have been giving efficient service in many plants. Other devices include Damper Regulators, Differential Pressure Regulators, Fan Engine and Stoker Control, Adjustable Chronometer Valves, etc. For air, water, draft and other services.

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In a Class by Itself

because of its simplicity, accessibility and the service it gives, is what engineers say of

Squires **Class "E" Pump Governor**

Better find out about this, and others of the Durable Line of

Squires Steam Specialties

Described in Catalogue E-11.
Sent upon request.

The C. E. Squires Company
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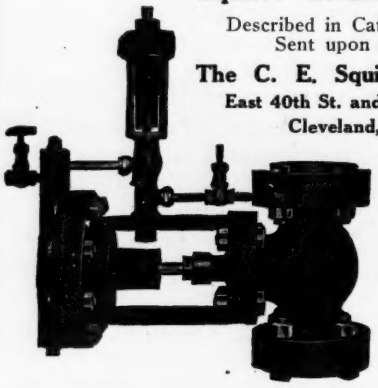

Squires
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FISHER
TRADE MARK REGISTERED

Equips Plants with

- Pump Governors
- Reducing Valves
- Back Pressure Valves
- Exhaust Relief Valves
- Air Traps
- Float Valves
- Exhaust Heads
- Steam Traps
- Pressure Regulators
- Liquid Level Controllers
- Boiler Compound Feeders
- Grease Traps and other specialties.

Forty-six years ago The Fisher Governor Co., Inc., placed its first pump governor on the market. Today, Fisher Automatic Specialties of many kinds, types and sizes built for the severest of requirements serve and save in the plants of leading concerns.

The Fisher Governor Co., Inc.
689 Fisher Bldg., Marshalltown, Ia.

VALVE MAKERS FOR OVER FIFTY YEARS

You can see it work *and test it by hand*

Chicago Power Show Space 45

The Davis Pressure Regulator is distinctive in its design and its operation. It provides automatic reduction of boiler pressure to the correct service pressures for heating, auxiliaries, process uses of steam, etc., and does this by simple, reliable principle of operation.

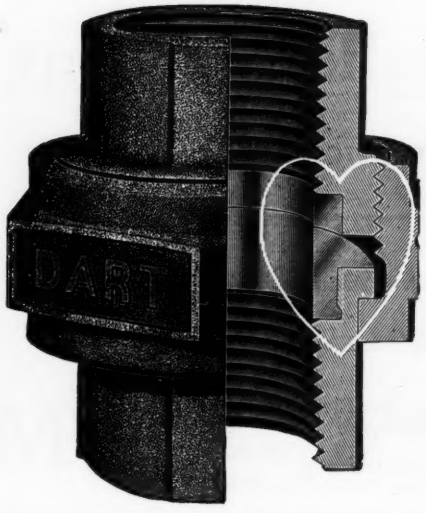
Pressure is balanced by weight, and there are no springs, diaphragm, packing, or other details to cause trouble. The counterweighted lever makes the action of the Davis Regulator visible, and it may be tested by hand at any time. Close regulation is consistently maintained.

Send for the Davis catalogue and get the detailed description.

DAVIS VALVE SPECIALTIES
STEAM SAVERS SINCE 1875

G. M. DAVIS REGULATOR CO., 429 Milwaukee Avenue, Chicago, Ill.
PPE 12-15 Gray

You Should Know DART Unions

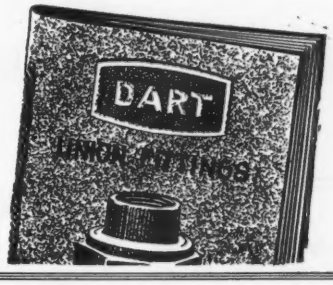


Note the double seat at the "Heart of the Dart"

The more you know about Dart Unions, the better you like them. We couldn't tell you in a month of Sundays so much about Dart Union Service as one Dart Union will demonstrate right in your own plant. Nevertheless, it is worth your while to send for the Dart Catalog "T." It's full of information for the power plant man. **But get the Sample Dart Union, too.** Try it out at a troublesome joint—and **watch its record.**

E. M. Dart Manufacturing Co.
Providence, Rhode Island
Sales Agents: The Fairbanks Co., New York, and at all branches.
Canadian Factory: Dart Union Co., Ltd., Toronto, Canada.

This 31-Page Catalog "T" and Sample Union Mailed Free



A Pressure Regulator

WITHOUT { **SPRINGS** / **STUFFING BOXES** / **WEIGHTS**

Will solve your problems accurately and simply

The MERCON Regulator Co.
53 W. Jackson Blvd., CHICAGO, ILL.

Rx "LET LOCKE REGULATE"

your troubles in Engine and Boiler Rooms

Hydraulic Damper Regulator
Improved 1925 Model
Trade LOCKE Mark

The Locke Hydraulic Automatic Damper Regulator was invented by Mr. N. C. Locke at a time when damper regulation was chiefly by hand and, at best, at a variation of 10 to 15 lbs. steam pressure.

The Locke Regulator makes it possible to automatically regulate from one to twenty dampers, from the smallest to the heaviest, at a variation of steam pressure of one pound or less. A Locke Regulator is as essential as coal or oil in the up-to-date power plant. It will work equally as good where coal or oil is used to make steam.

SOME LOCKE STEAM SPECIALTIES:

Atmospheric Relief Valves
Back Pressure Valves
Balanced Valves
Combination Pressure Regulators
Damper Regulators
Boiler Feed Pump Governors
Engine Stops
"New Era" Reducing Valves
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Non-Return Stop Check Valves
Paper Drying Regulators
Automatic Safety Shut-off Valves
Steam Separators
Open Float Traps
Water Seal Traps
Vacuum Breaker Valves
Water Regulators
Vacuum Pump Regulators

LOCKE REGULATOR CO., 176 North St., Salem, Mass.
Steam Doctors since 1871
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of 15 to 48% Shown in this Book

This book is not simply a catalog. It contains an abundance of evidence and testimony which shows the amazing economies obtained with Automatic Control of Temperature in offices and workrooms.

It shows how Powers Control in many of America's leading firms has reduced fuel consumption 15 to 48 per cent; and how the output of workers can be increased, and the quality of their work improved; and other profitable advantages.

For limited distribution only—
—among plant owners, chief engineers and other executives interested in eliminating waste and increasing the profits of their company.

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Gentlemen:
I shall be glad to receive a copy of your book SHOP and OFFICE TEMPERATURES.

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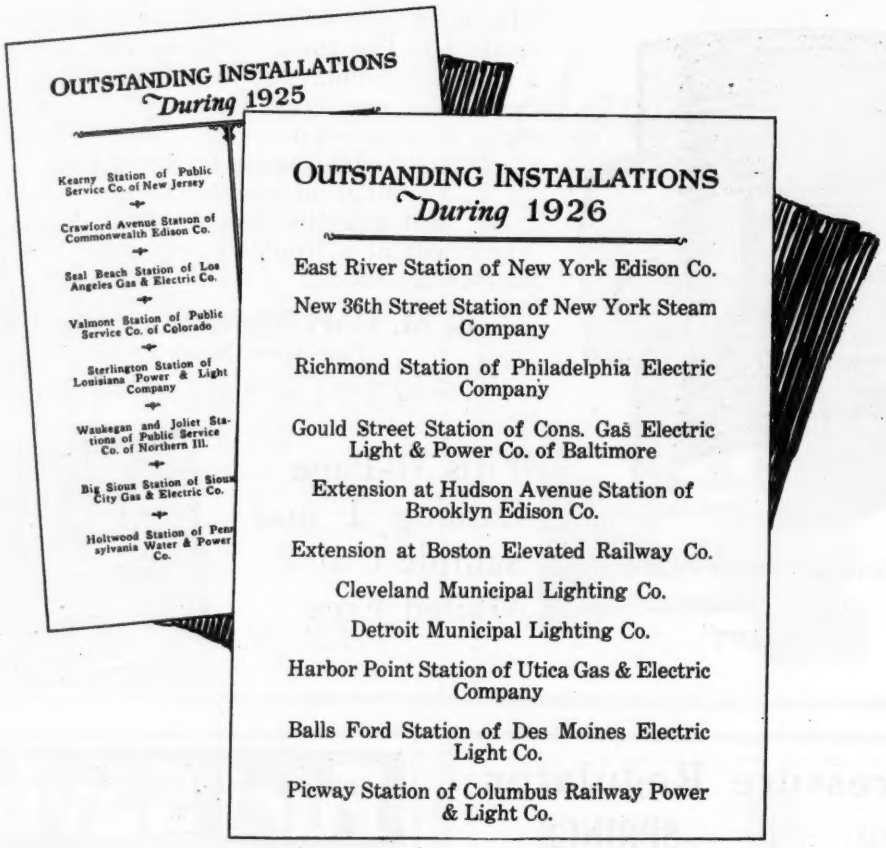
Another Year of Leadership


OUTSTANDING INSTALLATIONS
During 1925
Kearny Station of Public Service Co. of New Jersey
Crawford Avenue Station of Commonwealth Edison Co.
Seal Beach Station of Los Angeles Gas & Electric Co.
Valmont Station of Public Service Co. of Colorado
Sterlington Station of Louisiana Power & Light Company
Waukegan and Joliet Stations of Public Service Co. of Northern Ill.
Big Sioux Station of Sioux City Gas & Electric Co.
Holtwood Station of Pennsylvania Water & Power Co.
OUTSTANDING INSTALLATIONS
During 1926
East River Station of New York Edison Co.
New 36th Street Station of New York Steam Company
Richmond Station of Philadelphia Electric Company
Gould Street Station of Cons. Gas Electric Light & Power Co. of Baltimore
Extension at Hudson Avenue Station of Brooklyn Edison Co.
Extension at Boston Elevated Railway Co.
Cleveland Municipal Lighting Co.
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Picway Station of Columbus Railway Power & Light Co.

Each year, a new group of the most prominent central stations is added to the list of leaders who select COPES Feed Water Regulators. Each year the COPES-equipped ranks are enlarged by thousands of lesser central stations and large and small industrial installations. Now, on more than 27,000 boilers COPES Regulators are controlling the feed water input with safety, accuracy and economy.

Write for Booklet "B"

NORTHERN EQUIPMENT CO., 165 Grove Drive, Erie, Pa.

Branch Plants in Canada, England, France, Germany, Austria and Italy

SYSTEM OF BOILER FEED CONTROL

A review of the year shows rapid advances in the use of Type "S" Differential Valves

They maintain constant pressure differential in feed water regulation on high pressures when used ahead of *any* make of regulator

MODERN boiler plant operation is turning to "S-C" Regulators and Type "S" Differential Valves to best meet the new conditions and more difficult services of high pressures and the requirements of latest designs of boilers.

Pioneers in Feed Water Regulation, in which field we have been serving power plants for 30 years, "S-C" inevitably developed the regulating equipment now used in high pressure central stations and industrial plants such as these listed at the right.

Type "S" Valve, as used in a recent test at Crawford Ave. Station with "S-C" Regulators, also may be used ahead of ALL OTHER MAKES of regulators to maintain desired constant excess over drum pressure at feed water regulator valve.

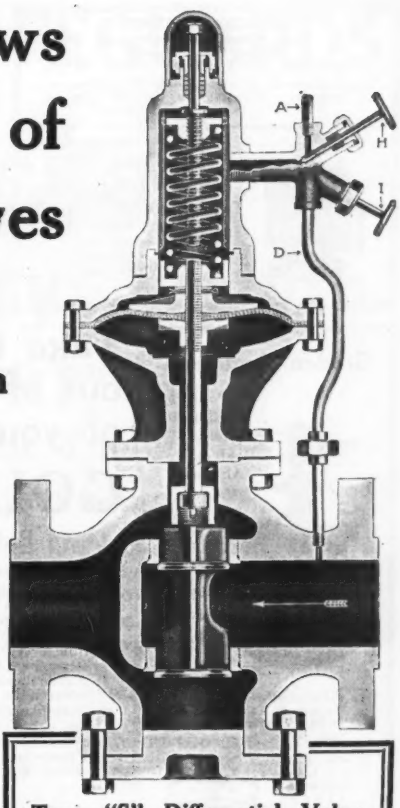
Consult our engineers freely on automatic boiler feed regulation at any pressure from 1,200 lb. down and for any size of boilers. They have proved their economy, durability and reliability in thousands of installations.

THE "S-C" REGULATOR MFG. CO.

Mechanical Regulation Engineers

Fostoria, Ohio

See us at Booth 35, Chicago Power Show.



Type "S" Differential Valve is super-sensitive and has these distinctive features:
No packed stems; no friction; excess pressure adjustment over long range; positive bypass; tight seating; scientifically designed diaphragm; entire unit made under one roof, not a job lot assembly unit; can be installed at any point and in any position; very heavy special diaphragm.
This valve will not hunt like a liquid weighted valve due to pulsations in lines.

What System of* FEED WATER REGULATION *is selected by Leading Industries?

A few of the thousands of users:

Crawford Ave. Station, 600 lb.
All "S-C" Regulators and Type "S" Differential Valves for fourth unit.

FORDSON PLANT
formerly River Rouge, where "S-C" Feed Water Regulator and Type "S" Differential Valve were selected for boiler recently remodelled to operate at 633% of rating instead of 250% to 300% as before.

Edgar Station, 1200 lb.
Philo Station, 600 lb.
"S-C" Feed Water Regulators, Boiler Feed Pump Governors, Pump Pressure Relief Valves, and High Pressure Drainage Controls. Sargent & Lundy, Engineers.

Twin Branch Station, 600 lb.
"S-C" Feed Water Regulators, Boiler Feed Pump Governors, Pump Pressure Relief Valves, and High Pressure Drainage Controls, and Type "S" Differential Valves. Sargent & Lundy, Engineers.

Columbia Station, 600 lb.
Hell Gate Station
Sherman Creek Station
Stanton Station, 750 lb.
Solvay Process, 750 lb.

"S-C" Regulating Valves, Drainage Controls, Pump Governors and Feed Water Regulators

GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Float Valves

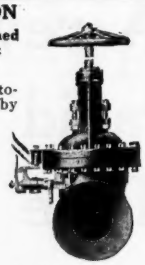
1. Automatically Maintain Uniform Water Levels in Tanks, Standpipes, etc.
2. Instantly Adjusted to Operate Quickly or Slowly.
3. Floats Swivel to any Angle—Most Satisfactory Float Valves Known.
4. No Metal-to-Metal Seats — No Water Hammer or Shock.
5. Cushioned by Water and Air. ½" to 24"

GOLDEN-ANDERSON
Patent Automatic High and Low Pressure Steam Traps

1. The first new departure in steam trap design in years.
2. 50 to 100% greater capacity than other traps of similar size.
3. Full area through discharge valve.
4. Extra Heavy Throughout — Very Durable — Will last a liftime — and **Always Work.**
5. Furnished Semi-Steel and Cast Steel for Superheat.

GOLDEN-ANDERSON
Pat. Cushioned Combined Throttle and Automatic Engine Stop Valves

1. Operate 3 ways: Automatically, by Hand, or by Electric Switch.
2. Prevent Fly-wheel Explosions.
3. "Double Corliss" Cushioned—No Pounding or Sticking.
4. Contain No Tight Fitting Parts.
5. Furnished in Angle and Globe Patterns for High or Low Pressures.
6. "Always Ready for Service."



Golden-Anderson

Pat. Cushioned Automatic Controlling Altitude Valves

No Freezing in Winter

1. Automatically Maintain Uniform Water Levels in Tanks, Standpipes, Reservoirs, etc.
2. For High or Low Pressure. Always Dependable.
3. No Floats or Fixtures used.
4. No Water Hammer or Shocks.

No freezing. Sizes to 24"

Take the dread word *"Danger"* out of your mind and the minds of your men with

GOLDEN-ANDERSON

Pat. Automatic Double-Cushioned Triple-Acting and Plain Non-Return Valves

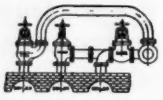
1. Automatically cut out the boiler the instant that a tube ruptures or other internal break occurs.
2. Automatically cut off the steam flow from every boiler the instant that a steam pipe breaks.
3. Automatically equalize the pressure between all boilers.
4. Automatically cut in a boiler, making accidents due to inaccurate steam gauge impossible.
5. Positively prevent back flow of steam into a cold boiler.
6. Can be closed by hand like ordinary stop valve, and arranged with "combination feature" to open valve like regular gate and globe valve.
7. The only valves that can be tested in service from boiler room floor.
8. Double Corliss Dash Pot that cushions in opening and closing.
9. Cannot pound, spin, stick or chatter.
10. By disconnecting pilot valve, the triple acting style can be changed into plain non-return.

"No Shutdown when a tube ruptures." **"No Explosion when a pipe bursts."**

4500 ***Ordered by the Steel Industry***

Elbow, Angle and Globe

"Hosts of References"



Double Extra Heavy Valves

GOLDEN-ANDERSON
Patent Automatic Cushioned Controlling Float Valves

1. They carry a constant water level in feed water heaters by perfectly controlling the flow of make-up water.
2. Operated by protected enclosed copper float.
3. Cushioned by both air and water.
4. Operate without hammering, sticking or chattering. No metal-to-metal seats.

Angle or Straightway

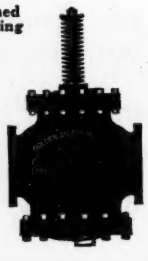
Sizes 1 in. to 24 in.

GOLDEN-ANDERSON
Pat. Automatic Cushioned Steam Pressure Reducing Valves

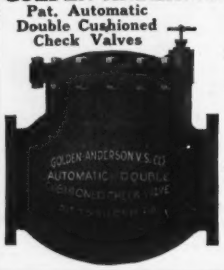
1. Maintain a constant reduced pressure.
2. Thoroughly cushioned.
3. No hammering, chattering or sticking.
4. No auxiliary valves or small by-passes to clog up.
5. No wire drawing.
6. Only one adjustment from the outside.
7. Double extra heavy throughout — practically indestructible.

GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Pressure Regulating Valves

1. Maintain a constant reduced pressure regardless of fluctuations on high pressure side.
2. Perfectly Cushioned by water and air. No metal-to-metal seats.
3. The best valves made for maintaining a constant low pressure where consumption is continuous.
4. Operate quickly or slowly as required—No attention necessary.
5. Positively no hammering or sticking. Sizes to 24 in.



GOLDEN-ANDERSON
Pat. Automatic Double Cushioned Check Valves



1. Especially adapted for Water Service.
2. For High or Low Pressure.
3. Thoroughly Cushioned. No Chattering, Hammering, or Sticking.
4. Globe or Angle Patterns up to 24 in.
5. Especially adapted for hydraulic elevator service.

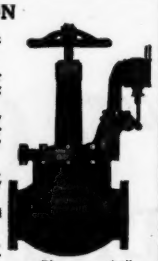
Double Extra Heavy Cast Steel Valves

These are especially adapted to super steam pressures and high superheat in modern central station service.

Valves with an absolute guarantee.

GOLDEN-ANDERSON
Pat. Cushioned Electric Water Service Valves

1. Give instant control of water distribution from pumping station in case of fire.
2. Open or close by electricity from distant points—a.c. or d.c. circuits. Also close by hand.
3. No waste of electricity. Current is on only few seconds.
4. Cushioned in opening and closing.
5. No water hammer, shock, sticking, surging or chattering.



Sizes to 24"

Golden-Anderson Valve Specialty Co., 1287 Fulton Bldg., Pittsburgh, Pa.

MODERN BOILER SAFEGUARDS

Model "WRT"

Sizes and prices on request.

Lonergan "BOE" Type Gauge

Our latest and sturdiest design in pressure gauges. Entire mechanism fully enclosed in dust and moisture-proof case. The improved gauge socket is built to stand roughest service. "B.O.E." Type Gauge is our best assurance for eliminating the nuisance of taking down gauges, losing parts and breaking glass. Write for folder showing design.

Water Gauge—Model "QC"

Model "QC" Water Gauge

Built for 200 to 500 lb. pressure, the chain pull instantly closes it from a distance when gauge glass breaks. Complete with Rods, Glass and 12 feet of Chain. Specify it to make safety and long service a certainty.

Lonergan Pop Safety Valve

Model "WRT" for Fire Tube and Return Tubular Boilers and "BOE" Type Gauge

ALL Lonergan Boiler, Steam and Gas Engine Safety Devices are built to meet—and exceed—every legal requirement. Pop Safety Valve Model "WRT" conforms to the recently revised A.S.M.E. Boiler Code. But we built it better than required.

Building better than necessary accounts for the world-wide use of Lonergan Devices. Their dependability and economy is assured, always, by the 54-year experience of this organization.

Model "WRT" Pop Safety Valve is the essential dependable safeguard to boilers and men—the latest development in our line.

Consider its advantages: greater strength without overweight; high lift, ample discharge; positive opening and gradual closing with minimum blowdown. Base outlet. Taken apart while on the boiler. Powerful cam lifting device set in any direction. Outside adjustment of blowdown ring. Load on spring equalized by ball joints on top and bottom spring steps.

High grade, high temperature resisting steel springs. The finest metals for the purpose to give least wear and corrosion.

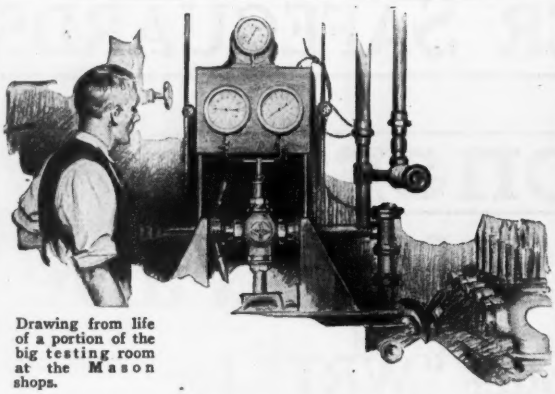
Write to us about your requirements. Our service engineers will answer promptly without charge. Booklets on any Lonergan Device, or complete catalogue No. 300, sent on request.

J. E. LONERGAN CO., 213 Race Street Philadelphia, Pa.

Established 1872

Lonergan Safety Steam Devices

Pop Safety Valves; Relief Valves; Gauges for Steam, Air, Vacuum, Temperature, Water, Altitude, Ammonia, Test; Gauge Boards; Clocks and Counters; Gauge Cocks; Steam Gauge Syphons; Oil Cups; Oil Pumps; Grease Cups; Multiple Oilers; Oil Gauges; Water Gauges; Whistles; Gauge Glass Cutters. Write us in what you are interested.



Drawing from life of a portion of the big testing room at the Mason shops.

If Jim Says They're Right They ARE Right

Not an occasional "one out of fifty" but **every** Mason Regulator must pass a series of exacting tests for accuracy and dependability under the eagle eye of Jim, the Mason testing engineer.

No matter what the type or size of pressure regulator, you may be sure when you specify **Mason** that its ability to meet the most exacting conditions of service it will be put to in your plant, has been thoroughly test-proved.

That's one reason why so many engineers have standardized on Mason Regulators throughout.

Our staff of experienced pressure control engineers is at your service. May we send you Catalog, installation blue prints or other information?

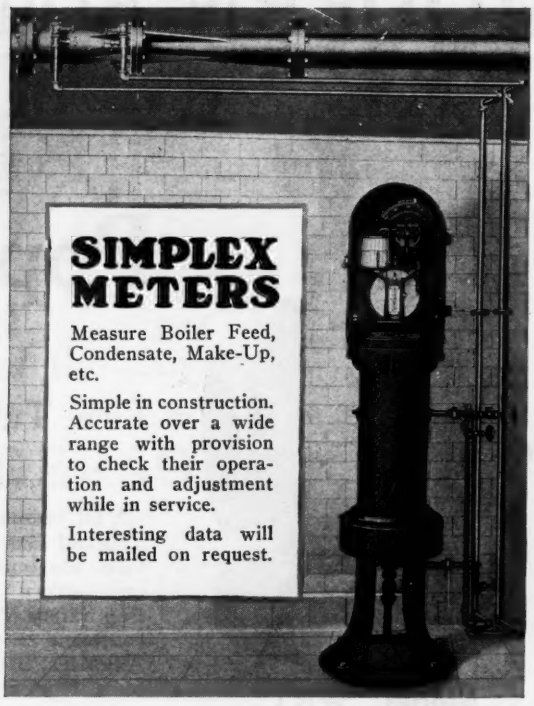
Mason test-proved regulators include:

- Reducing Valves
- Pump Pressure Regulators
- Boiler Feed Line Regulators
- Damper Regulators
- Fan Engine Regulators
- Pump Speed Governors
- Vacuum Regulators
- Balanced Valves
- Strainers.

354

Mason Regulators

MASON REGULATOR CO.
Boston, Mass.
San Francisco Office, 606 Howard Street



SIMPLEX METERS

Measure Boiler Feed, Condensate, Make-Up, etc.

Simple in construction. Accurate over a wide range with provision to check their operation and adjustment while in service.

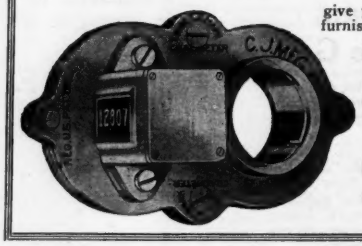
Interesting data will be mailed on request.

SIMPLEX VALVE AND METER CO
6751 Upland Street, Philadelphia

Know the Truth

about how much coal is used in your plant, and whether or not more economy could be practiced.

C. J. COAL METERS



give you the exact facts and furnish you an accurate record of the amount used each day under each boiler. Fit any underfeed stoker having an accessible revolving shaft.

Write for literature.

C. J. Mfg. Co.
3427 N. Fifth Street
Philadelphia, Pa.

BACHARACH
MANOMETERS — UPRIGHT

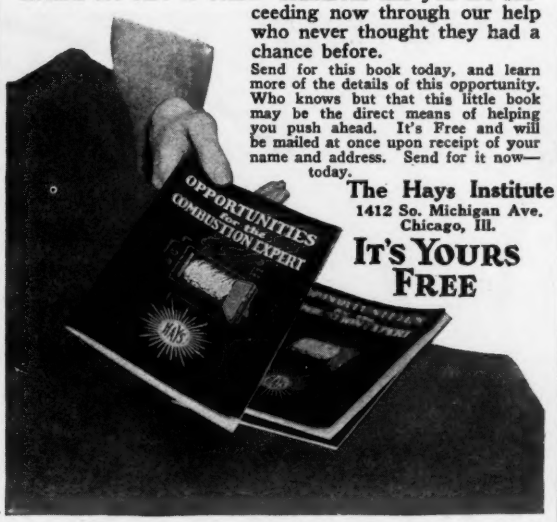
For forced drafts and condensers. The readings are plain and easily made; the figures of the scale are visible from almost any angle. All Bacharach Manometers have adjustments for the reading scale. A slight turn of the knob of the adjuster moves the scale and adjusts the zero. Bulletin 130.

Bacharach Industrial Instrument Co.
7006 Bennett St. Pittsburgh, Pa.

More Money? *yes! but how?*

Read the stories of hundreds of men just like yourself who have worked up to better jobs, with more responsibility and bigger money, through the help given them by The Hays Institute in their course in Fuel and Combustion Engineering. If you are ambitious to do better for yourself, let Hays help you do better by your job. Results are sure to come. Hundreds like you are succeeding now through our help who never thought they had a chance before.

Send for this book today, and learn more of the details of this opportunity. Who knows but that this little book may be the direct means of helping you push ahead. It's Free and will be mailed at once upon receipt of your name and address. Send for it now—today.



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IT'S YOURS FREE

You Can Rely Upon the COCHRANE FLOW METER

It is fully guaranteed

Delicate parts have been avoided.

The actuating member is a substantial U-tube supported on a knife edge.

There is no stuffing box.

The integrator is exceedingly simple and does not interfere with the deflection of the balance.

The user can quickly verify the accuracy of his Recorder, as a calibrating weight is supplied with each instrument.

Errors due to improper location or insertion of the pressure pipes are eliminated.

See our exhibit at the Chicago Power Show, Booths Nos. 446 and 447.

Catalog H-1247 mailed on request

COCHRANE CORPORATION

3144 North 17th St., Philadelphia, Pa.

METERS HEATERS SOFTENERS FILTERS
VALVES DRAINERS TRAPS
DEAERATORS SEPARATORS

321

The RICHARDSON Weigh Larry

FOR THE MODERN POWER PLANT BUILT TO SUIT PLANT CONDITIONS

Used by

Public Service Gas & Electric Company of New Jersey

E. I. DuPont de Nemours Company

Manhattan Rubber Company

International Motor Company

Newburyport Gas & Electric Company, Massachusetts

The entire larry is built by engineers of 35 years' experience in the art of Weighing.

Each larry built to meet individual needs.

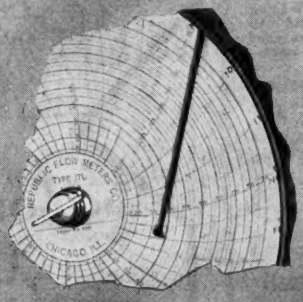
Install a RICHARDSON and obtain the essential records of coal consumed and prove your own efficiency.

RICHARDSON SCALE COMPANY

Clifton, New Jersey

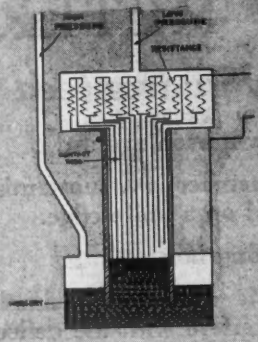
Chicago Wichita New York Omaha Boston Minneapolis Pittsburgh

THE ELECTRICAL
A Product of



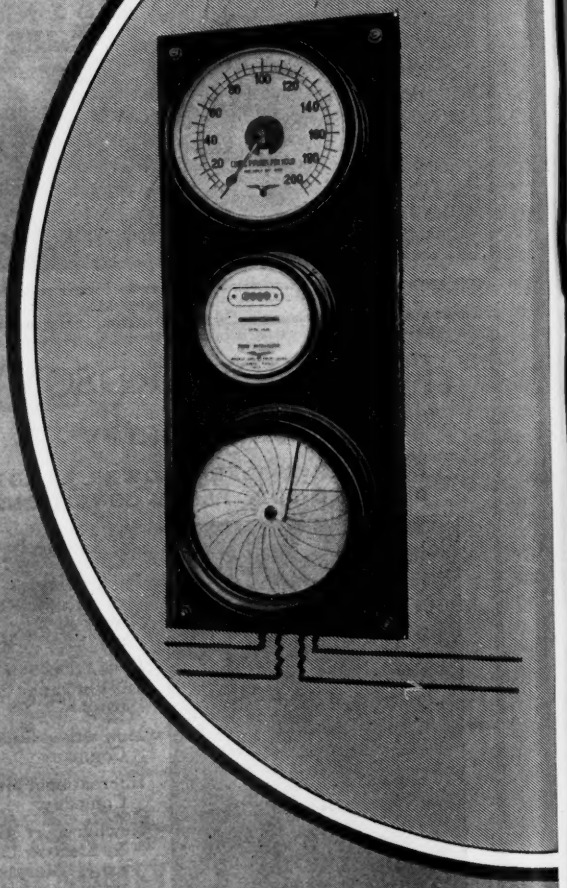
CONTINUOUS PEN LINE CHARTS

On both the strip and circular charts the flow is recorded by a continuous pen line. This gives a clear strong record, which can be easily read even when the flow is fluctuating rapidly. The clock mechanism may be either electrical or mechanical to meet conditions at the customers plant.



METER BODY

The Republic Meter Body is essentially a mercury Manometer, simple in design and positive in operation. All uncertain mechanical appliances such as levers, floats or balances, always associated with friction, are eliminated. All meter bodies are subjected to 1000 pounds pressure tests in order to guarantee that they will withstand the most severe demands.



SCALE

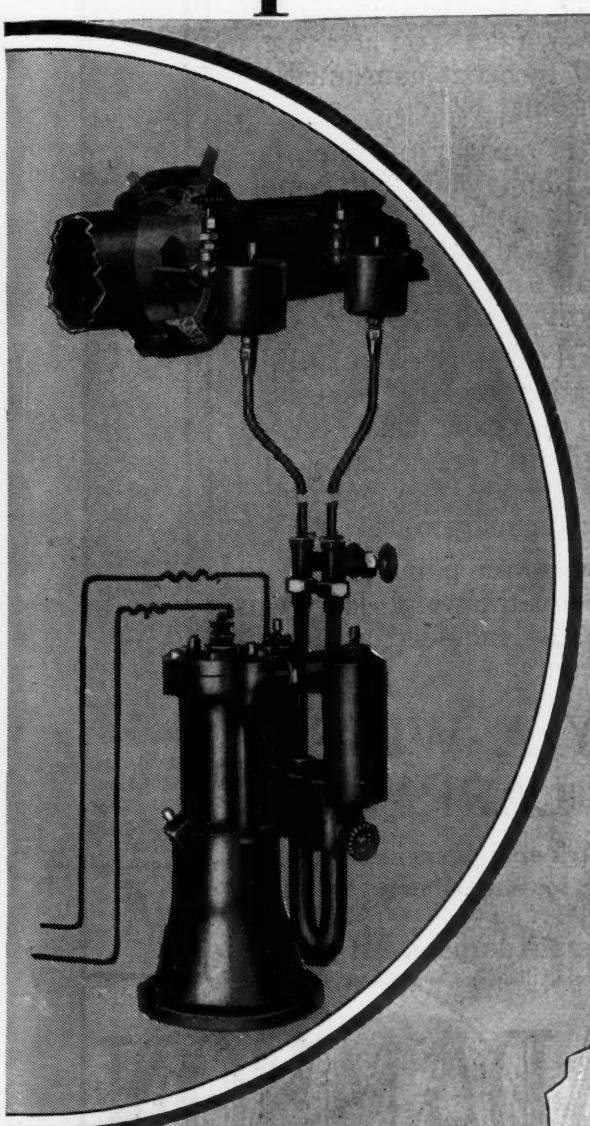
The Republic Resistance Element is made up of ninety-one graduated rods, each of which is connected to a definite electrical resistance. Each step representing such a small fraction of the total flow that the record and indication is continuous for all practical purposes. This form of step contact was selected above all others because it permits absolute accuracy in manufacture which means accuracy in operation. The Republic Electrical Resistance is the only element, the accuracy of which can be tested when removed from the meter; this also makes it possible to check the meter accurately and positively at every range.

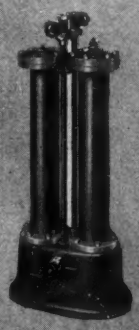
BRANCH OFFICES IN

Republic Flow

2224 Diversey Parkway

FLOW METER Experience



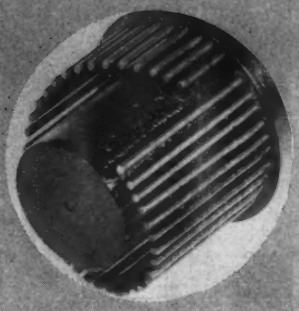


HIGH VELOCITY METER

The Republic High Velocity Meter has a special form of meter body operating on exactly the same principle as the standard Republic Meter, but designed to take care of extremely high velocities and pressures met with in exceptional cases.

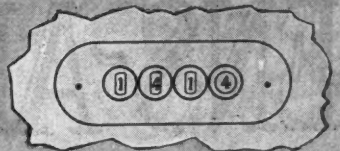
CONTACT RODS

The Republic Contact Rods are made of pure nickel. Damage from corrosion even over long periods of time is practically impossible. The illustration is an enlarged view of an element after eight years of service. Any point on the step contact may be checked by the factory or customer both as to mechanical accuracy of the rod itself and for electrical accuracy of the resistance.



INTEGRATOR

The Republic Integrator is entirely independent of any clock mechanism, either mechanical or electrical and matches in accuracy the central station watt hour meter. Like the Republic Indicator and Recorder, it is basically an electrical instrument admitting of the degree of accuracy possible only in electrical instruments. It is inherently independent of any voltage or cycle changes in current supply and is therefore not concerned with voltage regulators, compensators or other devices of this nature. The Republic Integrator counter mechanism is of the speedometer type, simple in design and easily read.



25 PRINCIPAL CITIES

Meters Co.

CHICAGO, U.S.A.

Install an S-A Larry and Weigh Every Pound of Coal that Is Burned

There is no way of knowing how much you burn per boiler horsepower unless you accurately weigh all the coal consumed by each particular stoker.

There is no way of determining which boiler unit is the most extravagant with fuel unless you weigh the coal delivered to each individual unit and carefully compute the results.

The S-A Weigh Larry fulfills these requirements of accurately weighing the coal and also is used for distributing from any gate under a suspended storage bunker to any stoker magazine.

In new power plants or in old boiler rooms the weigh larry can be profitably included as an actual necessity.

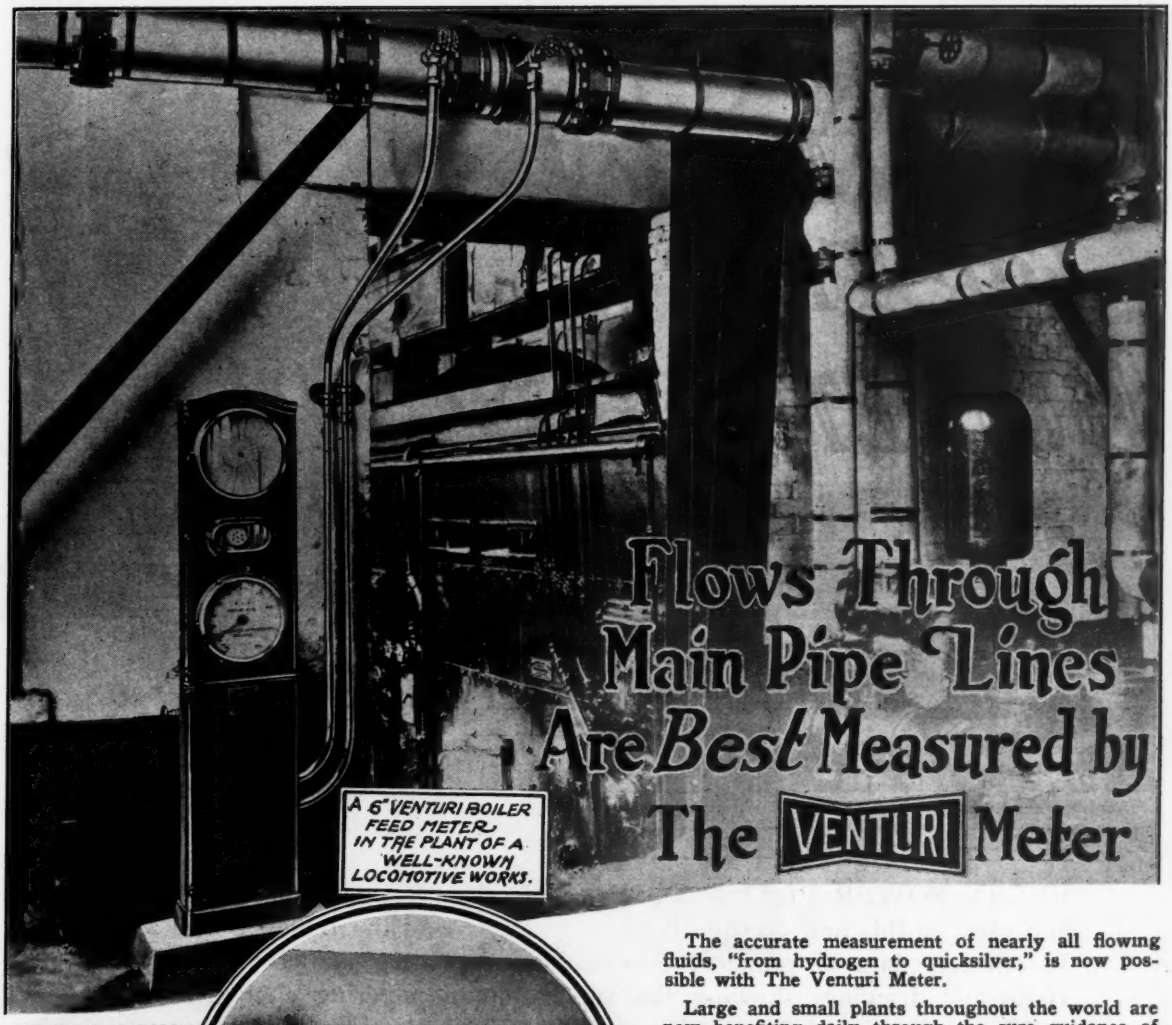
BUY A WEIGH LARRY

Ask an S-A engineer for our estimate

Stephens-Adamson Mfg. Co.

Plants: Aurora, Illinois; Los Angeles, California

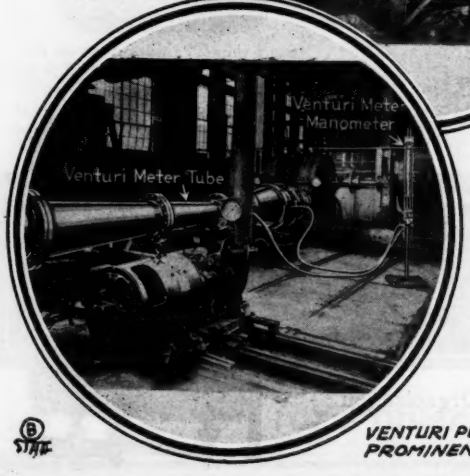
STEPHENS-ADAMSON



Flows Through Main Pipe Lines Are *Best* Measured by The VENTURI Meter

A 6" VENTURI BOILER FEED METER IN THE PLANT OF A WELL-KNOWN LOCOMOTIVE WORKS.

CONCRETE UPSTREAM CONE OF THE LARGEST METER IN THE WORLD—CATSKILL AQUEDUCT SUPPLY TO NEW YORK CITY.



VENTURI PUMP TESTING PLANT OF PROMINENT PUMP MANUFACTURER

The accurate measurement of nearly all flowing fluids, "from hydrogen to quicksilver," is now possible with The Venturi Meter.

Large and small plants throughout the world are now benefiting daily through the sure guidance of the Venturi in the economic generation of power or in industrial processes.

Detailed advertisement becomes unnecessary when such concerns as these use the Venturi extensively:

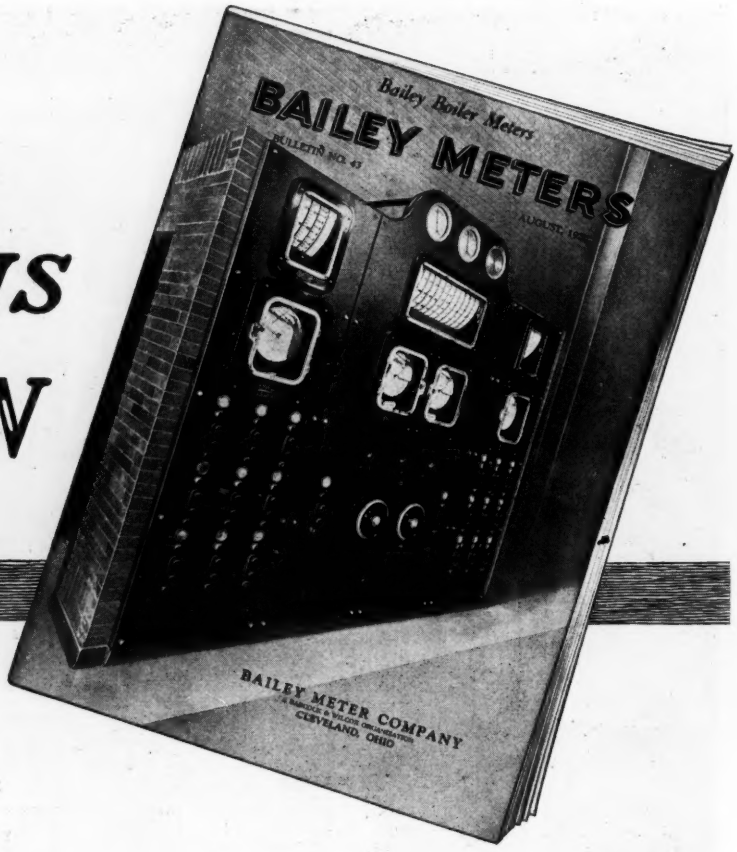
New York Edison Co.	DuPont Co.
Brooklyn Edison Co.	Detroit Edison Co.
Cleveland Elec. Illuminating Co.	The Viscose Co.
	Procter & Gamble Co.
Ohio River Power Co.	Standard Oil Co.
Southern California Edison Co.	Solvay Process Co.
	Illinois Steel Co.
American Gas & Elec. Co.	American Ice Co.

The Venturi might do great things for YOUR plant. Helpful bulletins are yours for the asking.

BUILDERS IRON FOUNDRY
PROVIDENCE, R. I.

The **VENTURI METER**

SEND FOR THIS BULLETIN



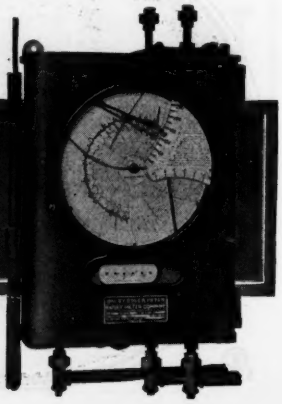
EVERY POWER PLANT ENGINEER will find something of real interest and value in this new 36-page Booklet descriptive of the Bailey Boiler Meter. It contains data of practical everyday use including numerous installation views and drawings showing the application of metering equipment which will be productive of the most economical boiler operation.

Bailey Boiler Meters record Steam Flow, Air Flow, Flue Gas Temperature and Rate of Coal Feed, thereby providing all of the essential information for establishing and maintaining the best operating efficiency. The most important losses in the generation of steam can be instantly determined from the chart records and faulty conditions can be rectified as soon as they occur. For further details write for your copy of Bulletin 43.

BAILEY METERS

BAILEY METER CO.
2013 E46TH ST. CLEVELAND, OHIO.
Bailey Meter Company Ltd. —— Montreal, Canada.
Industrial Combustion Engineers Ltd. London, England.

A Babcock-Wilcox Organization

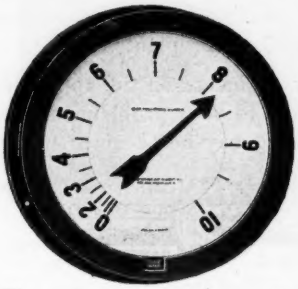


Flow Meter, CO_2 Meter Flue-Gas Pyrometer

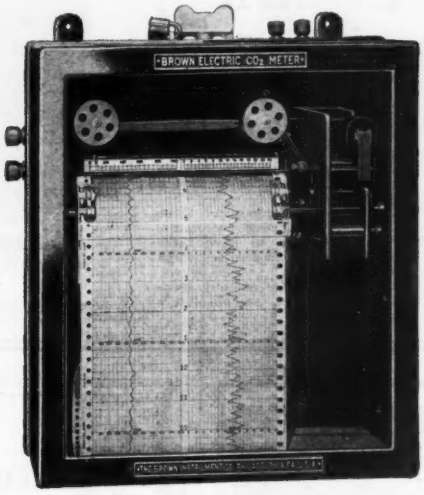
The "BIG THREE" in Power Plant Management

Every one electric. Every one rugged, accurate, dependable. Every one a BROWN instrument. Can be connected or disconnected to or from any point at a turn of a switch. Recorders may be in office, indicators in boiler room. Practically no distance limit. An ideal line for centralized control —the modern principle of efficient management.

Write for data.



The only flow meter operating on the "inductance bridge" principle. Indicating, Recording, Signalling, Controlling Models. Circular or strip chart recorders. 20 other features. Get Catalog No. 20.



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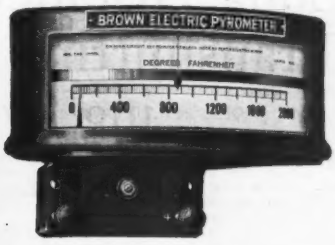

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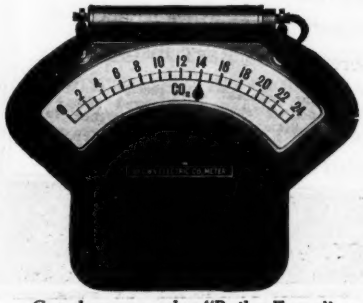

Cut shows popular "Boiler Front" type Brown Electric Co_2 Meter. 12-inch, illuminated dial. Other models, indicating, recording, controlling, signalling. Advanced thermol-conductivity principle. Get Catalog No. 33.

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District offices located at New York, Boston, Pittsburgh, Columbus, Cleveland, Detroit, Chicago, Indianapolis, Birmingham, St. Louis, Tulsa, Houston, El Paso, Los Angeles, San Francisco, Denver, Salt Lake City, Montreal.

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Records and
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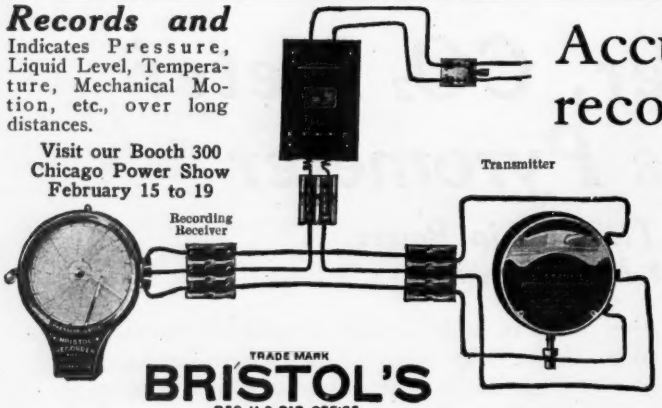

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Long Distance Electric Transmitting and Recording System

HUNDREDS of users have written of the savings obtained by this system. Here's what some say:

"We are pleased to inform you that the Long-Distance Liquid Level Recording Gauge is giving us the very best of satisfaction in its operation, and gives the very information sought at the time of its purchase."

"The installation has been very satisfactory and is quite accurate."

"This system has been of good service to us and has resulted in a great saving of fuel, due to the fact that we never carry any more pressure at the plant than is necessary."

"We can certainly recommend these instruments to any of your customers, and if you would care to have them write us, we would be glad to tell them of their operation here."

"These chart records at our generating stations, we feel, are absolutely indispensable."

Accurate Indications and records at any required distance make operation as simple as if close by . . .

This Bristol's system is centralizing records of water level for Water Works and Hydro-Electric plants; of temperature for Central Heating plants; of gas-pressure in mains for Controlling Stations as well as records of all kinds for large industrial and power plants.

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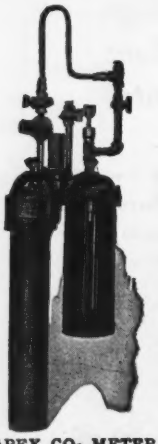
APEX CO_2 Recorders



may be placed in the Chief Engineer's office, while Auxiliary CO_2 Indicators guide the Fireman.

Flue Gas Temperature may be recorded on the same chart with the CO_2 if desired.

TROUBLE-PROOF INEXPENSIVE SIMPLE

APEX CO_2 METER which actuates recorder and indicator.

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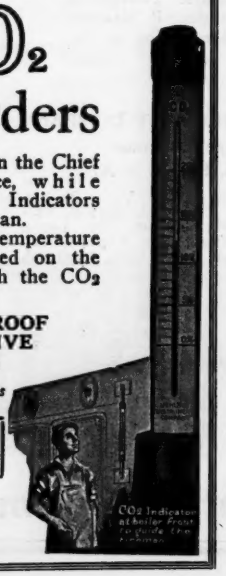

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Iron and Oil Removal Apparatus—Filtration Equipment—Water Conditioning Apparatus of every description

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For Maintenance Efficiency ~

ARE you using Weston Model 155 for quick precise measurements, for locating power leaks, for equalizing circuit loads, for correcting low voltage conditions, for general maintenance of electrical equipment? ¶ This Weston Model has these uses—a truly versatile model design for the hardest use, yet accurate and dependable over extremely long periods. ¶ This model is provided as A. C. Voltmeters, Ammeters and Milliammeters. They are light in weight and easily portable. There may easily be uses of Weston equipment already in your possession to which you have not applied it. ¶ Our staff is eager to be of assisttance in this way and will be glad to answer queries with regard to it promptly.

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Tycos

temperature instruments at Hunlock Creek Plant

INITIAL capacity of this new station of the Luzerne County Gas & Electric Corporation at Hunlock Creek, Pa., is 20,000 kw. and the present building provides for 20,000 kw. more, with plans for development of 190,000 kw. on the present site.

By reference to the leading article in the Oct. 1, 1926, issue of Power Plant Engineering, you will note the careful planning of this station for capital investment in relation to thermal efficiency.

As with many other leading power plants where temperature is so vital a part of the problem, *Tycos* indicating thermometers were selected for their dependable, rugged construction and maintained accuracy.

Have the *Tycos* book on instruments for Steam Power Plants at your finger tips. Promptly sent on application.

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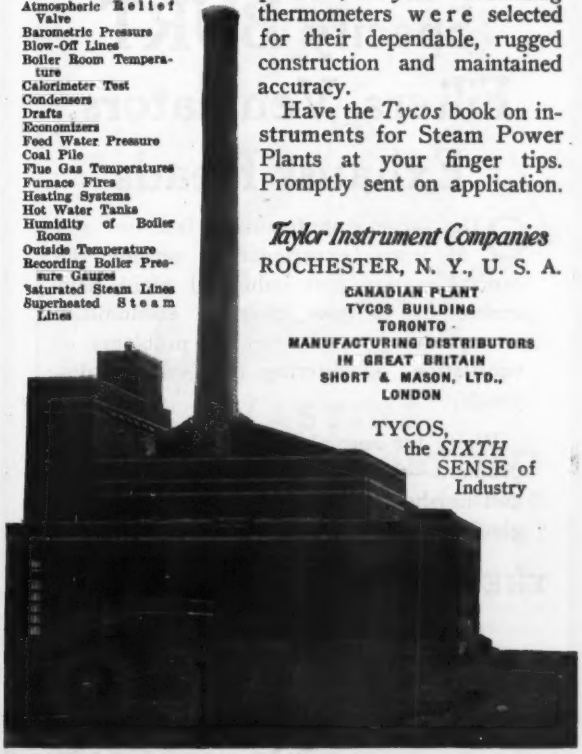

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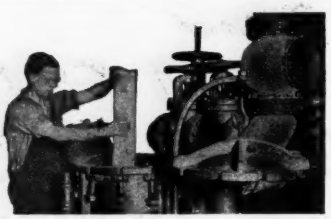

The Blackburn-Smith Feed Water Filter and Grease Extractor prevents troubles due to oil deposits in the Boiler, saves coal and water by making it safe to use hot returns, drips, etc., and is so easy to clean, and so dependable, that some day you'll be sorry you didn't install it years ago.

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STRAINER
Protects pumps, condensers, etc., by removing solids from the water supply.

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Protects boilers by removing dirt from feed water and oil from condensation.

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Tried for 40 years

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Just put them on your boilers and end all danger of shutdowns and low water levels.

Penberthy Injectors are themselves the highest type of boiler insurance.

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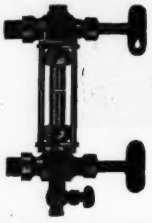
is as noted for reliability and the automatic protection it gives as the injector itself. Write.



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will save ONE CARLOAD OF COAL OUT OF EVERY SIXTEEN IN YOUR PLANT.

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of your feed water will be made by our specialists and the right Hawk-Eye Compound recommended for your use without obligation.

Don't have high fuel bills and less steaming capacity in your plant because of scale in your boilers when a one-pound piece of Hawk-Eye a day will keep a 100-hp. boiler clean.

Write us fully. No cost or obligation.

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VISIBILITY

is close to perfection with this "PBH" Water Gauge Adapter!

PAT APP FOR

Applied to any water column, or direct to boiler or tank, this Adapter makes the water level most easy to see. Put it on the gauges in your plant—the results are surprising.

Built for high and low pressures. Safety and service secured.

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The Adapter is shown above with a "PBH" Quick Closing Water Gauge applied to water column. Patent Applied For.

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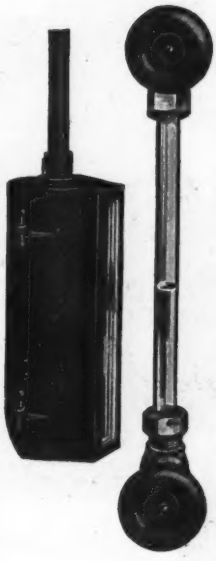
Water Gauge Illuminator



This device is being used in some of the largest plants in the country.

It protects your lamps when gauge glass breaks.

Water line is magnified, assuring a correct reading.

Suitable for 60-watt lamp, furnished with waterproof socket and connection for ½" conduit.

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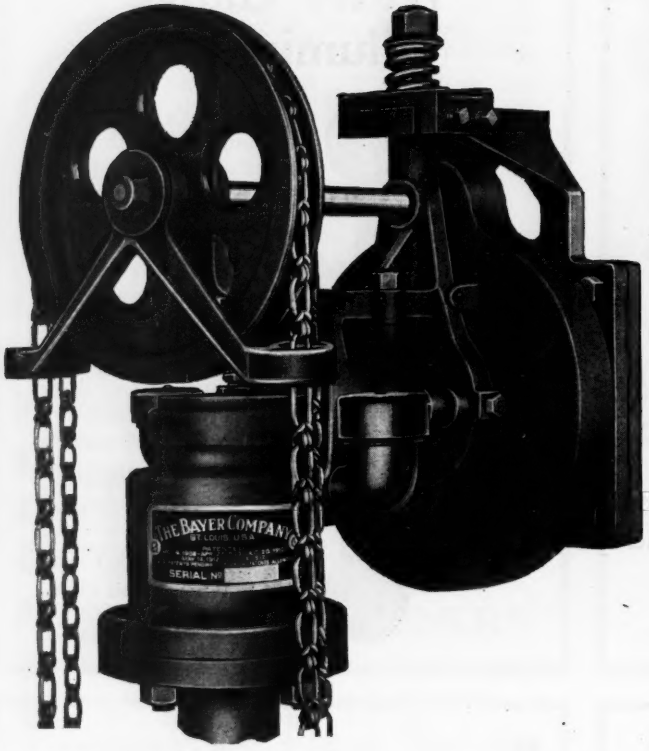
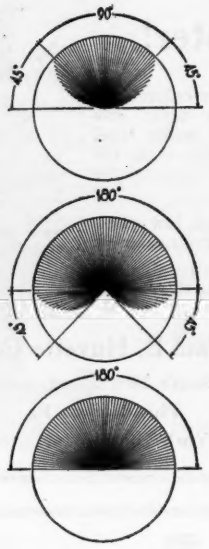
Manufactured by Vastine Engineering Products Corp.

A BAYER for every type of boiler



Model "K-2"
Balanced Valve-in-Head

What an Engineering Difference this feature makes:



This graph shows the action of steam from that type of blower in which the valve opens after the rotation of the element has begun. Fully one-half of the arc blown is used opening and closing the valve. This results in low pressure during these periods, and therefore insufficient cleaning.

This second graph shows what happens when the attempt is made to bring the ordinary valve in the head blower (of graph above) up to required efficiency within 180° cleaning arc. Note the valve must open and close at 45° beyond the full arc, resulting in a 25% loss of steam.

The opposite graph clearly illustrates the BAYER PRINCIPLE — in which the Bayer Valve opens wide, with full blowing force, a moment before the element begins to revolve, and closes the instant the element has ceased to rotate — giving a full-arc cleaning efficiency without loss of steam.

Consulting and Chief Engineers

—recognize the Engineering Correctness and Advantages of this Principle and its embodiment in the Bayer Superior Design. That is why they are including the Bayer Balanced-Valve-in-Head, together with the Bayer Non-Warping, Air-Cooled Element in their specifications.

All Bayer Soot-Blowers and Equipment are *exclusively* the Invention and Development of Bayer Specialized Engineers, and are protected by Patents Granted or Pending.

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There's a BAYER Blower for every type of Boiler

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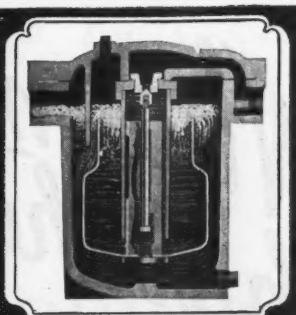
There's a BAYER Representative in your territory

ILLINOIS *Eclipse* TRAP



THE TRAP WHICH IS ALWAYS

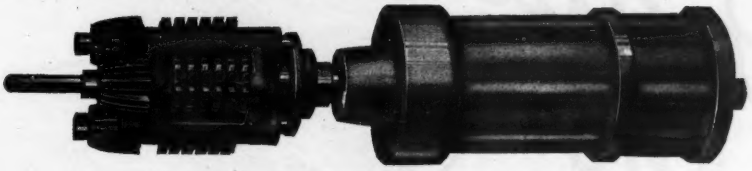
TIGHT CLOSED or WIDE OPEN

A radical advance in Trap Design.
No wire-drawing. No steam leakage.
You will admit this after reading Bulletin No. 33.
We offer you a 60-day trial of this trap, at our expense.

Let us send you Bulletin No. 33 today.

ILLINOIS ENGINEERING COMPANY, CHICAGO

A Boiler Tube Is No Place for Insulation



Roto 4″ Heavy Duty Air-Driven Tube Cleaner

Scale Is a Very Efficient Insulator

THE ROTO COMPANY, Sussex Ave. and Newark St., NEWARK, N. J.

Chase the Soot and Save Repairs by Using

PILLEY'S

Combination Flue Brush and Scraper

It is an efficient tool which removes the soot and scale and leaves the tubes shining like new.

The PILLEY is easy to operate. One turn of the handle contracts the scraper so that it will easily enter the tube. A turn in the opposite direction expands it to full size so that it comes in direct contact with the soot. The iron scraper breaks off the crust and the fine wire brush sweeps it out, leaving the tube perfectly clean.

Pilley's Combination Flue Brush and Scraper not only saves repairs, it saves Coal, also.

Made in all sizes from 2 inches to 6 inches. Price, $1.00 per diameter inch. Your Jobber Sells Them.

Pilley Packing & Flue Brush Mfg. Co.

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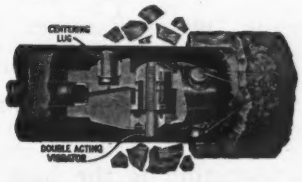
Get the TORPEDO for fire tube boilers

It cleans the tubes thoroughly and does not injure them. Operated by air or steam.



You can try it out on one boiler and if you don't like it, return it. Write for it today.

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Marion Equipment

Soot Blowers for water tube boilers; for fire tube boilers; Hand Fired Stokers; Marion Scottdale Grates; Marion Interlocking Grates; Marion Rocking and Dumping Grates; Keystone Rocking and Dumping Grates; Portable Kiln Grates; Forced Draft Blowers; Boiler Fronts, etc.; Coal Mining Equipment; Coal Crushers, Coal and Coke Handling Machinery; Gas and Oil Engines.

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VULCAN *Diagonal* Method of Blowing

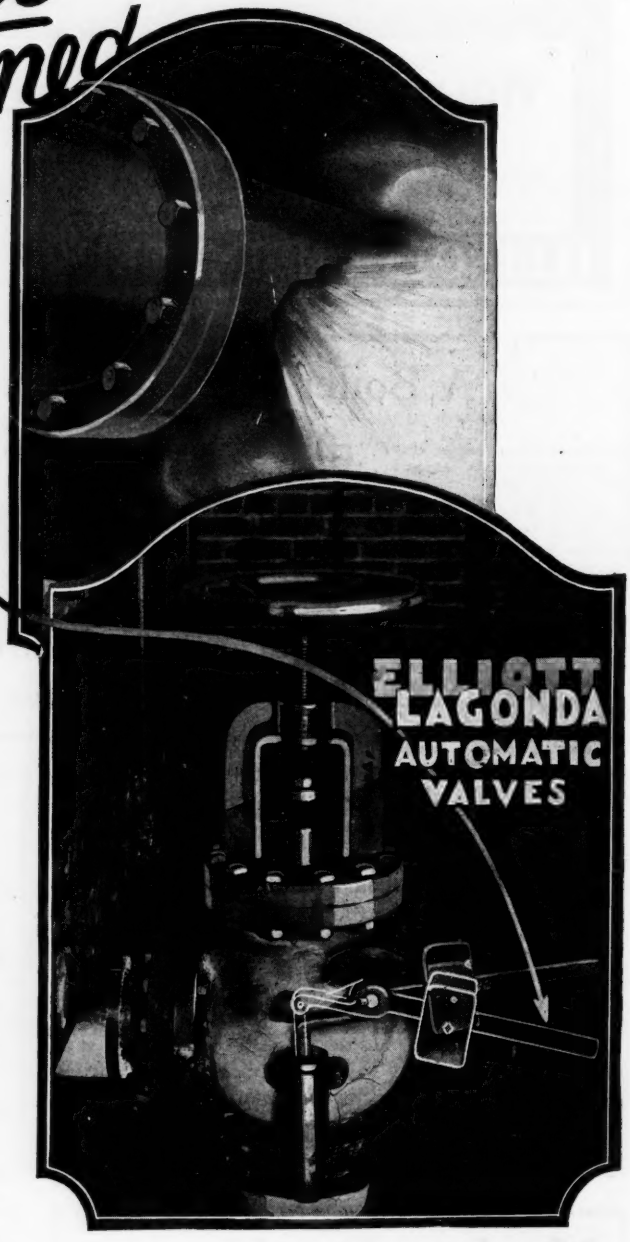
takes advantage of the diagonals formed by the tubes, in the staggered tube type of boilers, through which cleaning jets of steam can pass, scrubbing along the tubes clear to the bottom row, but never directly against them.

Special bulletins describing Vulcans for various types of boilers will be gladly sent on request.

Vulcan Soot Cleaner Co.
Vulcan Bldg., Dubois, Pa.

What might have happened

What did happen



When excessive volumes of steam start through the valve, *in either direction*, it operates immediately. The movement of the counterweighted arm, adjusted for normal steam flow, is the only visible indication of grave damage averted.

There is nothing imaginative in this episode. It has happened scores of times. "Pipe line ruptured, but the valve closed promptly. No damage" —or "water hammer opened up pipe line to turbine. Automatic valves on all boilers shut immediately."

Prevention is the best form of safety insurance. It is practised by all plants that have installed Elliott-Lagonda Automatic Valves.

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STEAM TURBINES, REDUCTION GEARS, DEAERATORS, HEATERS, CONDENSERS, AIR EJECTORS, AUTOMATIC HIGH-RETURN VALVES, BLOW-OFF VALVES, GREASE EXTRACTORS, STRAINERS, SEPARATORS

S-1101

The 19th Annual Textbook *and* Reference Number *of* POWER PLANT ENGINEERING

will be the January 1, 1927, *Specialized Number on*

POWER PLANT DEVELOPMENT

IN ITS constant endeavor to give helpful service to its readers, Power Plant Engineering will publish on January 1, 1927, its Annual Specialized Reference and Textbook Number.

These Annual January 1st Numbers have attained a height of usefulness that has caused many engineers to voluntarily write us that a single one of these numbers is worth the price of their entire year's subscription for 24 numbers.

In the next regular issue you receive, you will be presented with more than 100 pages of editorial text, data and illustrations that will bring the whole subject of "Power Plant Development" up to date and into the future as far as it is now indicated.

It will be a complete textbook of the most authoritative information on the subject and will excel in its comprehensive treatment of power plant development.

Power plant authorities of the highest standing have given the best of their thought and experience to its contents. Expense without stint has been given by its publishers to gathering the material and presenting it in a clear and useful form.

Manufacturers will show every type of machinery, equipment and supplies in the advertising pages of this Number.

What an opportunity this Textbook and Reference Number will present to power plant men to increase the authoritativeness of their opinions, to help them to better their positions and to assume a new measure of leadership among their fellows and in the economics of the nation!

In past years orders for extra copies of these January 1st Specialized Numbers have been received from consulting and designing engineers who are responsible for improvements in plants, and for the machinery, equipment and supplies used in them, as well as from many power companies for the use of their different department heads.

Years after date of publication urgent requests are received from subscribers for copies of these Annual Specialized Numbers to replace copies that have been accidentally lost from their files.

Offers of cash premiums rarely bring forth back copies to fill these requests, as they are evidently highly prized by every recipient and usually each edition is exhausted soon after publication.

To avoid disappointment it is suggested that you see that your annual subscription is entered and extra copies ordered at once so that a sufficiently large edition may be printed. All regular subscribers will receive it as a part of their yearly subscriptions.

The annual subscription to Power Plant Engineering, 24 issues, including the January 1 Specialized Number, is $2.00 a year. Extra copies of the January 1 Number on "Power Plant Development" are 50 cents each, postage prepaid.

Send remittances and orders for both annual subscriptions and extra copies direct to the Technical Publishing Company, 53 West Jackson Blvd., Chicago.

Printing on the January 1, 1927, "Power Plant Development" Number commences on December 16, after which time the edition cannot be enlarged. Therefore we urge you to consider your requirements for executives or special reference use and

Order Extra Copies at Once

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Stearns Conveyor Co., The, Cleveland, Ohio.
Stephens-Adamson Mfg. Co., Aurora, Ill.
Webster Mfg. Co., The, Chicago.

ASH TANKS.
Conveyors Corp. of America, Chicago.
Hagan Co., George J., Pittsburgh.

BABBITT METAL.
Magnolia Metal Co., New York.

BAROMETERS.
Taylor Inst. Co.'s, Rochester,

BEARING METAL.
Magnolia Metal Co., New York.

BEARINGS.
National Tube Co., Pittsburgh.

BELT CONVEYORS.
Jeffrey Mfg. Co., The, Columbus, O.
Stearns Conveyor Co., The, Cleveland, Ohio.
Stephens - Adamson Mfg. Co., Aurora, Ill.
Webster Mfg. Co., The, Chicago.

BELT DRESSING.
Dixon Crucible Co., Jos., Jersey City, N. J.
Standard Oil Co. (Indiana), Chicago, Ill.
Stephenson Mfg. Co., Albany.

BELT DRIVES
Smidth & Co., Inc., F. L., New York, N. Y.

BELTING.
Goodyear Tire & Rubber Co., Inc., The, Akron, O.
New York Belting & P'k'g Co., New York.
Pioneer Rubber Mills, San Francisco, Calif.
Quaker City Rubber Co., Philadelphia.
United States Rubber Co., New York, N. Y.

BELTING, SILENT CHAIN.
Link-Belt Co., Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.

BLOWERS, FAN & FURNACE.
Air Preheater Corp., The, New York.
Buffalo Forge Co., Buffalo,
Coppus Engineering Corp., Worcester, Mass.
De Laval Steam Turbine Co., Trenton, N. J.
Ingersoll-Rand Co., New York.
New York Blower Co., Chicago.
Terry Steam Turbine Co., Hartford, Conn.
Wing Mfg. Co., L. J., New York.

BLOWERS, FORCED DRAFT.
New York Blower Co., Chicago.
Sturtevant Co., B. F., Hyde Park, Mass.

BLOWERS, PORTABLE.
Allen & Billmyre Co., Inc., New York.
Buffalo Steam Pump Co., Buffalo, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Marion Mach., Fdry. & Supply Co., Marion, Ind.
Pilley Pkg. & Flue Brush Mfg. Co., St. Louis, Mo.
Vulcan Soot Cleaner Co., Du Bois, Pa.
Webster, Howard J., Philadelphia, Pa.

BLOWERS, PULVERIZED COAL.
Buffalo Forge Co., Buffalo,

BLOWERS, STEAM.
Schutte & Koerting Co., Philadelphia.

BLOWERS, TUBE.
Bayer Co., The, St. Louis, Mo.
Diamond Power Spec. Corp., Detroit, Mich.
Marion Mach., Fdry. & Supply Co., Marion, Ind.

BLOWERS, TURBINE.
Allen & Billmyre Co., Inc., New York.
Moore Steam Turbine Corp., Wellsville, N. Y.
Wing Mfg. Co., L. J., New York.

BOILER BAFFLES.
Betson Plastic Fire Brick Co., Rome, N. Y.
Engineer Co., The, New York,
McLeod & Henry Co., Troy, N. Y.
Quigley Furnace Specialties Co., Inc., New York.

BOILER CAP CLEANERS.
Lagonda Mfg. Co., Springfield, Ohio.

BOILER CASING.
Walsh & Weidner Boiler Co., The, Chattanooga, Tenn.

BOILER COMPOUND.
Botfield Refractories Co., Philadelphia, Pa.
Dearborn Chemical Co., Chicago.
Hawk-Eye Compound Co., Blue Island, Ill.
McLeod & Henry Co., Troy, N. Y.
Paige & Jones Chemical Co., Inc., New York.

BOILER COMPOUND FEEDERS.
Hills-McCanna Co., Chicago, Ill.

BOILER FEED WATER, PURIFYING APPARATUS.
Griscom-Russell Co., New York.
Paige & Jones Chemical Co., Inc., New York.
Permutit Co., New York, N. Y.
Scaife & Sons Co., Wm. B., Pittsburgh.

BOILER FRONTS.
McLeod & Henry Co., Troy, N. Y.

BOILER MOUNTINGS.
Lunkenheimer Co., Cincinnati.

BOILER SEAM PROTECTORS.
National Boiler Protector Co., Dayton, Ohio.

BOILER SETTING CEMENT.
Betson Plastic Fire Brick Co., Rome, N. Y.
Botfield Refractories Co., Philadelphia, Pa.
Harbison - Walker Refractories Co., Pittsburgh, Pa.
Huyette Co., Inc., The Paul B., Philadelphia.
Insulating Products Corp., New York, N. Y.
Obermayer Co., The S., Chicago.
Plibrico Jointless Firebrick Co., Chicago, Ill.
Queen's Run Refractories Co., Inc., Lock Haven, Pa.
Quigley Furnace Specialties Co., Inc., New York.
Walsh Fire Clay Products Co., St. Louis, Mo.

BOILER SETTINGS.
Betson Plastic Fire Brick Co., Inc., Rome, N. Y.
Botfield Refractories Co., Philadelphia, Pa.
Harbison - Walker Refractories Co., Pittsburgh, Pa.
McLeod & Henry Co., Troy, N. Y.
Obermayer Co., The S., Chicago.
Plibrico Jointless Firebrick Co., Chicago, Ill.
Queen's Run Refractories Co., Inc., Lock Haven, Pa.
Quigley Furnace Specialties Co., Inc., New York.
Walsh & Weidner Boiler Co., The, Chattanooga, Tenn.
Walsh Fire Clay Products Co., St. Louis, Mo.
Webster, Howard J., Philadelphia, Pa.

BOILER SKIMMERS.
Sims Co., The, Erie, Pa.

BOILER TUBE CLEANERS.
General Spec. Co., Buffalo, N. Y.
Lagonda Mfg. Co., Springfield, Ohio.
Liberty Mfg. Co., Pittsburgh.
Pierce Co., The Wm. B., Buffalo, N. Y.
Roto Co., The, Hartford, Conn.

BOILER TUBES.
Babcock & Wilcox Tube Co., The, Beaver Falls, Pa.
Bethlehem Steel Co., Inc., Bethlehem, Pa.
Murray Iron Works Co., Burlington, Iowa.
National Tube Co., Pittsburgh.
Reading Iron Co., Reading, Pa.
Scully Steel & Iron Co., Chicago.

BOILER WALL COATINGS.
Botfield Refractories Co., Philadelphia, Pa.
Insulating Products Corp., New York, N. Y.

BOILERS.
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Babcock & Wilcox Co., N. Y.
Badenhausen Corp., Cornwells Heights, Pa.
Casey-Hedges Co., The, Chattanooga, Tenn.
Connelly Boiler Co., The D., Cleveland, O.
Edge Moor Iron Co., Edge Moor, Del.
Heine Boiler Co., St. Louis.
Kingsford Fdry. & Mach. Wks., Oswego, N. Y.
Ladd Water Tube Boiler Co., Pittsburgh, Pa.
Murray Iron Works Co., Burlington, Iowa.
Nuway Boiler & Engineering Co., Chicago.
Springfield Boiler Co., Springfield, Ill.
Union Iron Wks., Erie, Pa.
Vilter Mfg. Co., Milwaukee.
Walsh & Weidner Boiler Co., The, Chattanooga, Tenn.
Webster, Howard J., Philadelphia, Pa.
Wickes Boiler Co., Saginaw.

BOOKS AND SCHOOLS.
Hays Institute, The, Chicago, Ill.

BREECHINGS.
Littleford Bros., Cincinnati, O.

BRUSHES, DYNAMO AND MOTOR.
Calebaugh Self-Lubricating Carbon Co., Inc., Philadelphia.
Dixon Crucible Co., Jos., Jersey City, N. J.

BRUSHES, GRAPHITE.
Dixon Crucible Co., Jos., Jersey City, N. J.

BRUSHES, WIRE.
Pilley Pkg. & Flue Brush Mfg. Co., St. Louis, Mo.

BUCKET ELEVATORS.
Jeffrey Mfg. Co., The, Columbus, O.
Link-Belt Company, Chicago.
Webster Mfg. Co., The, Chicago.

BUCKETS, COAL HANDLING
Jeffrey Mfg. Co., The, Columbus, O.

CAR DUMPERS.
Wellman - Seaver - Morgan Co., The, Cleveland, Ohio.

CARRIERS, PIVOTED BUCKET.
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Webster Mfg. Co., The, Chicago.

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Bethlehem Steel Co., Inc., Bethlehem, Pa.
Fuller - Lehigh Co., Fullerton, Pa.
Hills - McCanna Co., Chicago.
Neemes Fdry. Inc., Troy, N. Y.

CEMENT, ASBESTOS.
New York Belting & P'k'g. Co., New York.

CEMENT, FURNACE.
Betson Plastic Fire Brick Co., Rome, N. Y.
Botfield Refractories Co., Philadelphia, Pa.
Harbison - Walker Refractories Co., Pittsburgh.
Insulating Products Corp., New York, N. Y.
McLeod & Henry Co., Troy, N. Y.
Plibrico Jointless Firebrick Co., Chicago, Ill.
Queen's Run Refractories Co., Inc., Lock Haven, Pa.
Quigley Furnace Specialties Co., Inc., New York.
Walsh Fire Clay Products Co., St. Louis, Mo.

CEMENT GUNS.
Cement-Gun Co., Inc., Allentown, Pa.

CEMENT, HIGH TEMPERATURE.
Botfield Refractories Co., Philadelphia, Pa.
Harbison - Walker Refractories Co., Pittsburgh, Pa.
Insulating Products Corp., New York, N. Y.
Johns-Manville, Inc., New York.
McLeod & Henry Co., Troy, N. Y.
Obermayer Co., The S., Chicago.
Plibrico Jointless Firebrick Co., Chicago, Ill.
Quigley Furnace Specialties Co., Inc., New York.

CEMENT, INSULATING.
Insulating Products Corp., New York, N. Y.
Walsh Fire Clay Products Co., St. Louis, Mo.

CEMENT, IRON.
Smooth-On Mfg. Co., Jersey City, N. J.

CHAIN WHEELS.
Babbitt Steam Specialty Co., New Bedford, Mass.

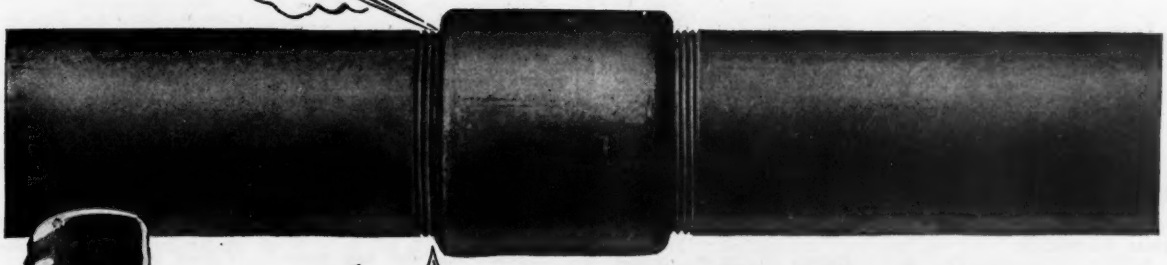
CHAINS, DRIVE.
Link-Belt Company, Chicago.
Morse Chain Co., Ithaca, N. Y.

CHIMNEYS.
American Chimney Corp., New York.
Springfield Boiler Co., Springfield, Ill.

CIRCUIT BREAKERS.
Cutter Co., The, Philadelphia.

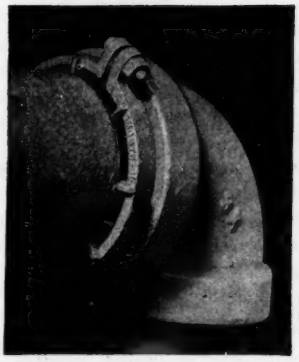
CLEANERS, BOILER TUBE.
General Specialty Co., The, Buffalo, N. Y.
Lagonda Mfg. Co., Springfield, Ohio.
Liberty Mfg. Co., Pittsburgh,
Pierce Co., The Wm. B., Buffalo.
Roto Co., The, Hartford, Conn.

"There's no excuse for that leak!"



SMOOTH-ON No. 1 in a SMOOTH-ON CLAMP

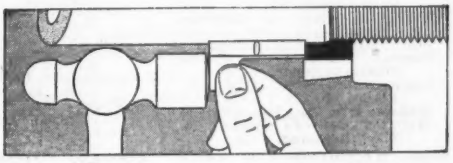
will stop it in a hurry —and you don't have to take the line down

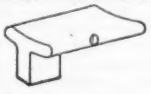


Smooth-On Clamp on a threaded fitting.

Smooth-On Clamp on a flanged joint. No interference with bolts or nuts. Note small space occupied by the clamp.

IT'S not like the old days when a lot of joints had to be broken and reassembled to "get" the bad one.





Method of tamping in Smooth-On with the tool furnished for the purpose.

To stop any new or chronic leak at pipe threads, merely put a Smooth-On Clamp around the pipe, shove and tighten it against the coupling, and tamp Smooth-On No. 1 against and into the leak. Expansion of the Smooth-On in hardening will do the rest. You can finish the whole job quickly and it is done **for good.** By **good,** we mean **good** in every sense of the word—a thoroughly tight joint that holds on iron, steel, brass or copper pipe, at any temperature and pressure, and **for the life of the line.** Under extreme temperature changes, the hardened Smooth-On expands and contracts in unison with the surrounding metal, so the seal remains solid and powerful. If you want to be ready for emergencies, your store room should always contain a few pounds of Smooth-On No. 1 and at least one Smooth-On Clamp for every pipe size in the plant.

Smooth-On No. 1 comes in 1 and 5-lb. cans and Smooth-On Clamps in all pipe sizes from 1 to 12-in. If your dealer can't supply you, write direct to us.

SMOOTH-ON HANDBOOK FREE
if you mail this coupon

SMOOTH-ON MFG. CO.,
Dept. 31, 570 Communipaw Ave., Jersey City, N. J.
Please send copy of the **Smooth-On** Handbook, 20th Edition.

Name .....

Address .....

.....

Do it with **SMOOTH-ON**

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Detrick Co., M. H., Chicago.
Fairbanks, Morse & Co., Chicago.
Hagan Co., George J., Pittsburgh.
Jeffrey Mfg. Co., The, Columbus, O.
Link-Belt Co., Chicago.
Stearns Conveyor Co., The, Cleveland, Ohio.
Stephens - Adamson Mfg. Co., Aurora, Ill.
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Furnace Engineering Co., New York.
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Stephens - Adamson Mfg. Co., Aurora, Ill.
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Williams Patent Crusher & Pulverizer Co., St. Louis, Mo.
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Link-Belt Company, Chicago.
Stearns Conveyor Co., The, Cleveland, Ohio.
Stephens - Adamson Mfg. Co., Aurora, Ill.
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Wellman - Seaver - Morgan Co., The, Cleveland, Ohio.
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Homestead Valve Mfg. Co., Homestead, Pa.
Powell Co., Wm., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.
COCKS, BLOW OFF.
Scully Steel & Iron Co., Chicago.
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National Pipe Bending Co., The, New Haven, Conn.
COMBUSTION APPLIANCES.
Bacharach Ind. Instrument Co., Pittsburgh, Pa.
Uehling Instrument Co., Paterson, N. J.
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Huyette Co., Inc., The Paul B., Philadelphia.
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Republic Flow Meters Co., Chicago, Ill.
Uehling Instrument Co., Paterson, N. J.
COMMUTATOR CEMENT.
Green Equipment Corp., Chicago.
COMMUTATOR COMPOUND.
Ohio Grease Co., Loundonville, Ohio.
COMMUTATOR DRESSER.
Green Equipment Corp., Chicago, Ill.
Ideal Commutator Dresser Co., Sycamore, Ill.
COMMUTATOR SLOTTERS
Green Equipment Corp., Chicago, Ill.
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Smooth-On Mfg. Co., Jersey City, N. J.
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Irving Iron Works Co., Long Island City, N. Y.
CONDENSER TUBE CLEANERS.
Lagonda Mfg. Co., Springfield, Ohio.
Roto Co., The, Hartford, Conn.
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American Steam Pump Co., Battle Creek, Mich.
Bethlehem Shipbuilding Corp., Bethlehem, Pa.
Binks Spray Equip. Co., Chicago, Ill.
Dean Bros. Co., Indianapolis.
Elliott Company, Jeannette, Pa.
Ingersoll-Rand Co., New York.
Manistee Iron Works, Manistee.
Ross Heater & Mfg. Co., Buffalo.
Schutte & Koerting Co., Philadelphia.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.
Worthington Pump & Machinery Corp., New York, N. Y.
CONDUIT, FIBRE.
Johns-Manville, Inc., New York.
CONVEYORS.
Brady Conveyors Corp., Chicago.
Combustion Engineering Corp., New York, N. Y.
Conveyors Corp. of America, Chicago, Ill.
Detrick Co., M. H., Chicago.
Hagan Co., George J., Pittsburgh.
Jeffrey Mfg. Co., The, Columbus, O.
Link-Belt Company, Chicago.
Stearns Conveyor Co., The, Cleveland, Ohio.
Stephens - Adamson Mfg. Co., Aurora, Ill.
Webster Mfg. Co., The, Chicago.
COOLERS, OIL.
Griscom-Russell Co., New York.
Ross Heater & Mfg. Co., Buffalo.
Schutte & Koerting Co., Philadelphia.
COOLING SYSTEMS.
Binks Spray Equip. Co., Chicago, Ill.
Cooling Tower Co., Inc., The, New York.
New York Blower Co., Chicago.
Power Plant Equipment Co., Kansas City, Mo.
Sturtevant Co., B. F., Hyde Park, Boston, Mass.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.
Yarnall-Waring Co., Philadelphia, Pa.
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Binks Spray Equip. Co., Chicago, Ill.
Cooling Tower Co., Inc., The, New York.
Power Plant Equipment Co., Kansas City, Mo.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.
COUNTERS REVOLUTION.
Lonergan Co., J. E. Phila.
COUPLINGS, FLEXIBLE.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
COUPLINGS, UNION.
Continental Valve & Equip. Co., Framingham, Mass.
Dart Mfg. Co., E. M., Providence, R. I.
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American Hoist & Derrick Co., St. Paul.
CRANES, LOCOMOTIVE.
American Hoist & Derrick Co., St. Paul, Minn.
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Pennsylvania Crusher Co., Philadelphia.
DE-AERATORS.
Ross Heater & Mfg. Co., Inc., Buffalo, N. Y.
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Brady Conveyors Corp., Chicago.
Conveyor Corp. of America, Chicago.
DOORS, FURNACE OBSERVER.
Vastine Sales Corp., Chicago, Ill.
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Engineer Co., The, New York,
DRYERS, ROTARY.
Fuller - Lehigh Co., Fullerton, Pa.
DUST SWEEPING SYSTEMS.
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DYNAMOS AND MOTORS.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
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Engberg's Elec. & Mech. Wks., St. Joseph, Mich.
Fairbanks, Morse & Co., Chicago.
Terry Steam Turbine Co., Hartford, Conn.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
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Power Specialty Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
EJECTORS.
Penberthy Injector Co., Detroit.
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Cutler-Hammer Mfg. Co., The, Milwaukee.
Green Equipment Corp., Chicago, Ill.
Ideal Commutator Dresser Co., Sycamore, Ill.
ELECTRICAL WIRES AND CABLES.
American Steel & Wire Co., Chicago and New York.
ELIMINATORS, AUTO. STEAM.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Robertson & Sons, Jas. L., N. Y.
ENGINE REPAIRS.
Murray Iron Works Co., Burlington, Iowa.
ENGINE STOPS, AUTOMATIC.
Locke Regulator Co., Salem, Mass.
Strong, Carlisle & Hammond Co., Cleveland, Ohio.
ENGINES, GAS AND GASOLINE.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
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Ingersoll-Rand Co., New York.
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Worthington Pump & Machinery Corp., New York, N. Y.
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EVAPORATORS.
Andale Engineering Co., Philadelphia.
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Griscom-Russell Co., New York.
EXHAUST HEADS.
Burt Mfg. Co., The, Akron, O.
Hoppes Mfg. Co., Springfield, O.
Robertson & Sons, Jas. L., New York.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Sims Co., The, Erie, Pa.
Wright-Austin Co., Detroit.
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Buffalo Forge Co., Buffalo,
EXPANDERS, TUBE.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
EXTRACTORS, OIL AND GREASE.
Blackburn-Smith Corp., The, New York.
Patterson-Kelley Co., The, New York.
Sims Co., The, Erie, Pa.
FANS, ELECTRIC.
Buffalo Forge Co., Buffalo.
Coppus Engineering Corp., Worcester, Mass.
New York Blower Co., Chicago.
Wing Mfg. Co., L. J., New York.
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Buffalo Forge Co., Buffalo,
Coppus Engineering Corp., Worcester, Mass.
Jeffrey Mfg. Co., The, Columbus, O.
New York Blower Co., Chicago.
Sturtevant Co., B. F., Hyde Park, Mass.
Wing Mfg. Co., L. J., New York.
FAUCETS.
Kennedy Valve Mfg. Co., Elmira.
FEED WATER FILTERS.
Andale Engineering Co., Philadelphia.
Blackburn-Smith Corp., The, New York.
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., New York.
Permutit Co., The, New York.
Scaife & Sons Co., Wm. B., Pittsburgh.
FEED WATER HEATERS AND PURIFIERS.
Andale Engineering Co., Philadelphia.
Bethlehem Shipbuilding Corp., Bethlehem, Pa.
Blackburn-Smith Corp., The, New York.
Cochrane Corp., Philadelphia.
Elliott Company, Jeannette, Pa.
Griscom-Russell Co., New York.
Hoppes Mfg. Co., Springfield, O.
Murray Iron Works Co., Burlington, Iowa.
National Pipe Bending Co., The, New Haven, Conn.
Patterson-Kelley Co., The, New York.
Robertson & Sons, Jas. L., New York.
Ross Heater & Mfg. Co., Buffalo.
Schutte & Koerting Co., Philadelphia.
Sims Co., The, Erie, Pa.
Superheater Co., The, New York.
Walsh & Weidner Boiler Co., The, Chattanooga, Tenn.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.
Worthington Pump & Machinery Corp., New York, N. Y.
Yarnall-Waring Co., Philadelphia, Pa.
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Blackburn-Smith Corp., The, New York.
Burt Mfg. Co., The, Akron, O.
Elliott Co., Jeannette, Pa.
Nugent & Co., Wm. W., Chicago, Ill.
Sims Co., The, Erie, Pa.
FILTERS, WATER.
Cochrane Corp., Philadelphia.
FILTRATION APPARATUS.
Paige & Jones Chemical Co., Inc., New York.
Permutit Co., The, New York.
Scaife & Sons Co., Wm. B., Pittsburgh.
FIRE BRICK.
Betson Plastic Fire Brick Co., Rome, N. Y.
Botfield Refractories Co., Philadelphia, Pa.
Harbison - Walker Refractories Co., Pittsburgh, Pa.
McLeod & Henry Co., Troy, N. Y.
Plibrico Jointless Firebrick Co., Chicago, Ill.
Queen's Run Refractories Co., Inc., Lock Haven, Pa.
Quigley Furnace Specialties Co., Inc., New York.
Walsh Fire Clay Products Co., St. Louis, Mo.
FIRE BRICK CEMENT.
Botfield Refractories Co., Philadelphia, Pa.
Insulating Products Corp., New York, N. Y.
McLeod & Henry Co., Troy, N. Y.
Walsh Fire Clay Products Co., St. Louis, Mo.
FIRE CLAY.
Botfield Refractories Co., Philadelphia, Pa.
McLeod & Henry Co., Troy, N. Y.
Obermayer Co., The S., Chicago.
Plibrico Jointless Firebrick Co., Chicago, Ill.
Queen's Run Refractories Co., Inc., Lock Haven, Pa.
Walsh Fire Clay Products Co., St. Louis, Mo.
FIRE HYDRANTS.
Howard Iron Works, Buffalo.
FITTING, FLANGE AND PIPE.
Continental Valve & Equip. Co., Framingham, Mass.
Fisher Governor Co., Inc., The, Marshalltown, Iowa.
National Valve & Mfg. Co., Pittsburgh, Pa.
Pittsburgh Valve, Fdry. & Construction Co., Pittsburgh.
Power Specialty Co., New York.
Scully Steel & Iron Co., Chicago.
FITTINGS, AMMONIA.
Vilter Mfg. Co., Milwaukee, Wis.
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Nugent & Co., Wm. W., Chicago, Ill.
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Dart Mfg. Co., E. M., Providence, R. I.
Kennedy Valve Mfg. Co., Elmira, N. Y.
FLOOR PLATES.
Scully Steel & Iron Co., Chicago.
FLOORING, NON-SLIPPING.
Irving Iron Works Co., Long Island City, N. Y.
FLOORING, OPEN STEEL.
Irving Iron Works Co., Long Island City, N. Y.
FLOORING, STEEL.
Irving Iron Works Co., Long Island City, N. Y.
FLOORING, VENTILATING.
Irving Iron Works Co., Long Island City, N. Y.
FLOW METERS.
Bacharach Ind. Instrument Co., Pittsburgh, Pa.
Bailey Meter Co., Cleveland, O.
Brown Instrument Co., The, Philadelphia, Pa.

"Thorough heat insulation always pays for itself"

"IN designing the heating system of the Maryland Casualty Company," said Henry Adams, Consulting Mechanical Engineer in charge, "we aimed to obtain the highest possible efficiency along with economy of upkeep. Each of the buildings of the company is connected by tunnels in which the various piping systems have been placed so as to be readily accessible at all times should repairs be necessary.

"We believe that thorough heat insulation always pays for itself, and for this reason we used extra-thick coverings in certain parts of the system. All high and medium pressure lines are covered with 2" thick 85% Magnesia, while low pressure lines have 1" thick covering. Boiler settings are also insulated with 2" thick 85% Magnesia with a half-inch finish coat of cement. This not only saves fuel and keeps the boiler room cooler, but if there are any leaks in the setting it reduces air leakage to a minimum."

HENRY ADAMS, *a leading consulting mechanical engineer of Baltimore. Many of the most important power and heating installations in the Baltimore territory have been made under Mr. Adams' direction.*

When it came to insulating materials which would measure up to the high standards set by Mr. Adams, Carey Heat Insulations were chosen because the test of actual experience, in heating plants all over the country, has shown Carey Heat Insulations to be unsurpassed. Unsurpassed not only in insulating efficiency, but in lasting durability as well. These superior insulating materials truly pay for themselves—and more—wherever installed. Write for full details.

THE PHILIP CAREY CO., *Lockland,* Cincinnati, Ohio

View of buildings of the Maryland Casualty Company—insured against fuel waste by the use of Carey Heat Insulations.

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For every need...from residence to super power plant

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Diamond Power Spec. Corp., Detroit, Mich.
General Specialty Co., The, Buffalo, N. Y.
Huyette Co., Inc., The Paul B., Philadelphia.
Marion Mach., Fdry. & Supply Co., Marion, Ind.
Pierce Co., The, Wm. B., Buffalo.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Vulcan Soot Cleaner Co., Du Bois, Pa.

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Bacharach Ind. Instrument Co., Pittsburgh, Pa.
Brown Instrument Co., The, Philadelphia, Pa.
Tagliabue Mfg. Co., C. J., Brooklyn.
Uehling Instrument Co., Paterson, N. J.

FLUE SCRAPERS.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Scully Steel & Iron Co., Chicago, Ill.

FORGINGS.
Bethlehem Steel Co., Inc., Bethlehem, Pa.

FURNACE BOTTOMS, CAST IRON, AIR-COOLED.
Allen-Sherman-Hoff Co., The, Philadelphia, Pa.

FURNACE CONSTRUCTION AND REPAIR.
Burke Engineering Co., Holland, Mich.
Obermayer Co., The S., Chicago.
Pilbrico Jointless Firebrick Co., Chicago, Ill.

FURNACE FIRE OBSERVER.
Vastine Sales Corp., Chicago.

FURNACE DOORS, OBSERVATION.
Vastine Sales Corp., Chicago, Ill.

FURNACE WALLS.
Obermayer Co., The S., Chicago.
Pilbrico Jointless Firebrick Co., Chicago, Ill.
Walsh Fire Clay Products Co., St. Louis, Mo.

FURNACES.
Burke Engineering Co., Holland, Mich.
Combustion Eng'r'g Corp., N. Y.
Hagan Co., George J., Pittsburgh.
Hofft Co., The M. A., Indianapolis, Ind.
Riley Stoker Corp., The, Worcester, Mass.

FUSE PLUGS.
Chicago Fuse Mfg. Co., Chicago.

FUSES.
Chicago Fuse Mfg. Co., Chicago.

GAS PRODUCERS.
Wellman - Seaver - Morgan Co., The, Cleveland, O.

GASKETS.
Crandall Packing Co., Palmyra, N. Y.
"Flexitallic" Gasket Co., Camden, N. J.
Garlock Packing Co., Palmyra, N. Y.
Goetze Gasket & P'k'g. Co., New Brunswick, N. J.
Johns-Manville, Inc., New York.
Metallo Gasket Co., New Brunswick, N. J.
New York Belting & P'k'g. Co., New York.
Power Specialty Co., New York.
Quaker City Rubber Co., Philadelphia.
Smooth-On Mfg. Co., Jersey City.
United States Rubber Co., New York, N. Y.

GASKETS, ASBESTOS, STEEL.
"Flexitallic" Gasket Co., Camden, N. J.

GATES, ASH.
Allen-Sherman-Hoff Co., The, Philadelphia, Pa.
Conveyors Corp. of America, Chicago.

GAUGE COCKS.
Hills-McCanna Co., Chicago.
Huyette Co., Inc., The Paul B., Philadelphia.
Keckley Co., O. C., Chicago, Ill.
Lonergan Co., J. E., Philadelphia.
Penberthy Injector Co., Detroit.
"S-C" Regulator Mfg. Co., The, Fostoria, Ohio.

GAUGE GLASS ILLUMINATORS.
Keckley Co., O. C., Chicago, Ill.

GAUGE GLASSES.
Jenkins Bros., New York, N. Y.
Keckley Co., O. C., Chicago, Ill.

GAUGE GLASS PROTECTORS.
Keckley Co., O. C., Chicago, Ill.

GAUGE TESTERS.
Fisher Governor Co., Inc., The, Marshalltown, Iowa.

GAUGES, BOILER WATER LEVEL, INDICATING AND RECORDING.
Brown Instrument Co., The, Philadelphia, Pa.

GAUGES, DIFFERENTIAL.
Bailey Meter Co., Cleveland, O.

GAUGES, DRAFT.
Bailey Meter Co., Cleveland, O.
Bristol Co., The, Waterbury.
Brown Instrument Co., The, Philadelphia, Pa.
Huyette Co., Inc., The Paul B., Philadelphia.
Pierce Co., The Wm. B., Buffalo.
Republic Flow Meters Co., Chicago.
Uehling Instrument Co., Paterson, N. J.

GAUGES, LIQUID LEVEL.
Bristol Co., The, Waterbury.
Republic Flow Meters Co., Chicago.

GAUGES, PRESSURE AND RECORDING.
Bacharach Ind. Instrument Co., Pittsburgh, Pa.
Bristol Co., The, Waterbury.
Lonergan Co., J. E., Philadelphia.
Uehling Instrument Co., Paterson, N. J.

GAUGES, WATER.
Huyette Co., Inc., The, Paul B., Philadelphia.
Keckley Co., O. C., Chicago, Ill.
Lonergan Co., J. E., Philadelphia.
Penberthy Injector Co., Detroit.

GEARS, DOUBLE HELICAL.
De Laval Steam Turbine Co., Trenton, N. J.

GEARS, REDUCTION.
De Laval Steam Turbine Co., Trenton, N. J.
Moore Steam Turbine Corp., Wellsville, N. Y.

GENERATING SETS.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Engberg's Elec. & Mech. Wks., St. Joseph, Mich.
Fairbanks, Morse & Co., Chicago.
Moore Steam Turbine Corp., Philadelphia, Pa.
Terry Steam Turbine Co., Hartford, Conn.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

GENERATORS, ELECTRIC.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Engberg's Elec. & Mech. Wks., St. Joseph, Mich.
Terry Steam Turbine Co., Hartford, Conn.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

GOVERNORS, PUMP.
Atlas Valve Co., Newark, N. J.
Chaplin-Fulton Mfg. Co., The, Pittsburgh.
Continental Valve & Equip. Co., Framingham, Mass.
Davis Regulator Co., G. M., Chicago, Ill.
Dean Bros. Co., Indianapolis.
Fisher Governor Co., Inc., The, Marshalltown, Iowa.
Foster Engineering Co., Newark.
Gardner Governor Co., The, Quincy, Ill.
Illinois Engineering Co., Chicago.
Locke Regulator Co., Salem, Mass.
Mason Regulator Co., Boston.
Northern Equip. Co., Erie, Pa.
"S-C" Regulator Mfg. Co., The, Fostoria, Ohio.
Squires Co., The C. E., Cleveland.
Strong, Carlisle & Hammond Co., Cleveland, Ohio.
Weston Electrical Instrument Corp., Newark, N. J.
Wright-Austin Co., Detroit.

GOVERNORS, STEAM ENGINES.
Gardner Governor Co., The, Quincy, Ill.

GRAPHITE.
Dixon Crucible Co., Jos., Jersey City, N. J.

GRATE BARS.
Flynn & Emrich Co., Baltimore.

GRATES.
Armstrong Mfg. Co., Springfield, Ohio.
Babcock & Wilcox Co., The, New York.
Burke Engineering Co., Holland, Mich.
Flynn & Emrich Co., Baltimore.
Hofft Co., The M. A., Indianapolis, Ind.
Kelly Foundry & Mach. Co., Goshen, Ind.
Marion Mach., Fdry. & Supply Co., Marion, Ind.
Murray Iron Works Co., Burlington, Iowa.
Neemes Fdry., Inc., Troy, N. Y.

GRATES, CHAIN.
Armstrong Mfg. Co., Springfield, Ohio.
Babcock & Wilcox Co., The, New York, N. Y.
Burke Engineering Co., Holland, Mich.

GRATING, STEEL.
Irving Iron Works Co., Long Island City, N. Y.

GRATINGS, VENTILATION.
Irving Iron Works Co., Long Island City, N. Y.

GREASE.
Cook's Sons, Inc., Adam, New York, N. Y.
Dearborn Chemical Co., Chicago.
Dixon Crucible Co., Jos., Jersey City, N. J.
Keystone Lubricating Co., Philadelphia.
Ohio Grease Co., Loudonville, O.
Standard Oil Co. (Indiana), Chicago, Ill.
Vacuum Oil Co., New York.

GREASE CUPS.
(See Oil and Grease Cups.)

HEAT EXCHANGERS.
Andale Engineering Co., Philadelphia.
National Pipe Bending Co., The, New Haven, Conn.

HEATERS, BLAST.
New York Blower Co., Chicago.

HEATERS FOR SPECIAL PURPOSES.
Babcock & Wilcox Co., The, New York.
Combustion Engineering Corp., New York, N. Y.
National Pipe Bending Co., The, New Haven, Conn.
Power Specialty Co., New York.

HEATERS, HOT WATER.
Griscom-Russell Co., New York.
National Pipe Bending Co., The, New Haven, Conn.
Patterson-Kelley, New York.
Powers Regulator Co., Chicago.
Ross Heater & Mfg. Co., Buffalo.

HEATERS, OIL.
Andale Engineering Co., Philadelphia.
National Pipe Bending Co., The, New Haven, Conn.
Patterson-Kelley Co., The, New York.
Power Specialty Co., New York.
Ross Heater & Mfg. Co., Buffalo.

HEATERS, STORAGE.
National Pipe Bending Co., The, New Haven, Conn.
Patterson-Kelley Co., The, New York.

HEATING DEVICES.
Cutler-Hammer Mfg. Co., The, Milwaukee.

HOISTS.
Nordberg Mfg. Co., Milwaukee.
Stearns Conveyor Co., The, Cleveland, Ohio.
Stephens-Adamson Mfg. Co., Aurora, Ill.
Wright Mfg. Co., Lisbon, O.

HOISTS, SKIP.
Stearns Conveyor Co., The, Cleveland, Ohio.
Stephens - Adamson Mfg. Co., Aurora, Ill.

HOPPERS AND BINS, COAL AND ASH.
Allen-Sherman-Hoff Co., The, Philadelphia, Pa.
Brady Conveyors Corp., Chicago.
Combustion Engineering Corp., New York, N. Y.
Frederick Iron & Steel Co., Frederick, Md.

HOSE.
Goodyear Tire & Rubber Co., Inc., The, Akron, O.
New York Belting & P'k'g Co., New York.
Pioneer Rubber Mills, San Francisco, Calif.
Quaker City Rubber Co., Philadelphia.
United States Rubber Co., New York, N. Y.

HYDRAULIC MACHINERY.
Bethlehem Steel Co., Inc., Bethlehem, Pa.

HYDROMETERS.
Taylor Inst. Co.'s, Rochester,

HYGRODEIKS.
Taylor Inst. Co.'s, Rochester,

ICE MAKING AND REFRIGERATING MACHINERY.
Ingersoll-Rand Co., New York.
Vilter Mfg. Co., Milwaukee, Wis.

INDICATORS, ENGINE.
Robertson & Sons, James L., New York, N. Y.

INJECTORS AND INSPIRATORS.
Penberthy Injector Co., Detroit.
Schutte & Koerting Co., Philadelphia.
Superheater Co., The, New York.

INSTRUMENTS, INDICATING.
Weston Electrical Instrument Corp., Newark, N. J.

INSULATING MATERIAL.
Carey Co., The Philip, Cincinnati, Ohio.
Cutler-Hammer Mfg. Co., The, Milwaukee.
Johns-Manville, Inc., New York.
Quigley Furnace Specialties Co., Inc., New York.

JOINTS, EXPANSION.
Griscom Russell Co., New York.
Howard Iron Works, Buffalo.
Ross Heater & Mfg. Co., Buffalo.
United States Rubber Co., New York, N. Y.
Wheeler Mfg. Co., C. H., Philadelphia.

LADDER STEPS, STEEL.
Irving Iron Works Co., Long Island City, N. Y.

LININGS, COAL BUNKER.
Wailes Dove-Hermiston Corp., New York.

LOADERS AND UNLOADERS.
Jeffrey Mfg. Co., The, Columbus, O.
Link-Belt Co., Chicago, Ill.

LUBRICANTS.
Cook's Sons, Inc., Adam, New York, N. Y.
Dearborn Chemical Co., Chicago.
Dixon Crucible Co., Jos., Jersey City, N. J.
Keystone Lubricating Co., Philadelphia.
Ohio Grease Co., Loudonville, O.
Standard Oil Co., (Indiana), Chicago, Ill.
Vacuum Oil Co., New York.

LUBRICATORS.
Cook's Sons, Inc., Adam, New York, N. Y.
Greene, Tweed & Co., New York.
Hills-McCanna Co., Chicago, Ill.
Keystone Lubricating Co., Philadelphia.
Lunkenheimer Co., Cincinnati.
Manzel Bros. Co., Buffalo, N. Y.
Nugent & Co., Wm. W., Chicago, Ill.
Ohio Grease Co., Loundonville, Ohio.
Powell Co., The Wm., Cincinnati.
Stephenson Mfg. Co., Albany.
Williams Valve Co., D. T., Cincinnati, Ohio.

LUBRICATORS, FORCED FEED.
Greene, Tweed & Co., New York.
Hills-McCanna Co., Chicago, Ill.
Lunkenheimer Co., Cincinnati.
Manzel Bros. Co., Buffalo, N. Y.

MECHANICAL DRAFT APPARATUS.
Buffalo Forge Co., Buffalo.
Coppus Engineering Corp., Worcester, Mass.
New York Blower Co., Chicago.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford, Conn.
Wing Mfg. Co., L. J., New York.

METERS, AIR AND GAS.
Bailey Meter Co., Cleveland, O.
Builders Iron Fdry., Providence,
Republic Flow Meters Co., Chicago, Ill.

METERS, BOILER.
Bailey Meter Co., Cleveland, O.
C. J. Mfg. Co., Philadelphia, Pa.
Republic Flow Meters Co., Chicago.
Yarnall-Waring Co., Philadelphia, Pa.

METERS, COAL.
Bailey Meter Co., Cleveland, O.
C. J. Mfg. Co., Philadelphia.
Republic Flow Meters Co., Chicago.
Richardson Scale Co., Clifton, N. J.

METERS, FEED WATER.
Bailey Meter Co., Cleveland, O.
Builders Iron Fdry., Providence,
Cochrane Corp, Philadelphia.
Hoppes Mfg. Co., Springfield, O.
Republic Flow Meters Co., Chicago.
Simplex Valve & Meter Co., Philadelphia, Pa.
Worthington Pump & Machinery Corp., New York, N. Y.
Yarnall-Waring Co., Philadelphia, Pa.

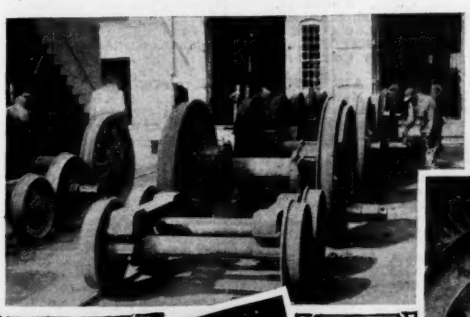
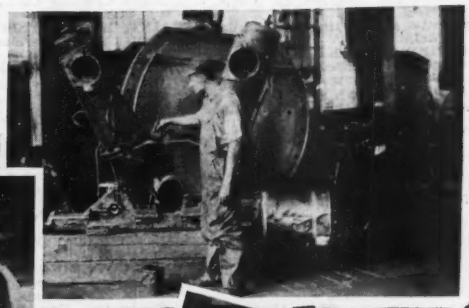
METERS, STEAM.
American District Steam Co., N. Tonawanda, N. Y.
Bailey Meter Co., Cleveland, O.
Builders Iron Fdry., Providence,
Republic Flow Meters Co., Chicago.

METERS, WATER.
Bailey Meter Co., Cleveland, O.
Builders Iron Fdry., Providence,
Cochrane Corp., Philadelphia.
Hoppes Mfg. Co., Springfield, O.
Republic Flow Meters Co., Chicago.
Simplex Valve & Meter Co., Philadelphia.

NOZZLES FOR ALL PURPOSES.
Bacharach Ind. Instrument Co., Pittsburgh, Pa.
Binks Spray Equip. Co., Chicago, Ill.
Cooling Tower Co., Inc., The, New York.
Schutte & Koerting Co., Philadelphia.
Uehling Instrument Co., Paterson, N. J.

OIL AND GREASE CUPS.
Cooks Sons, Inc., Adam, New York, N. Y.
Keystone Lubricating Co., Philadelphia.
Lonergan Co., J. E., Philadelphia, Pa.
Ohio Grease Co., Loudonville, O.
Penberthy Injector Co., Detroit.

The Choice of 77 Railroads

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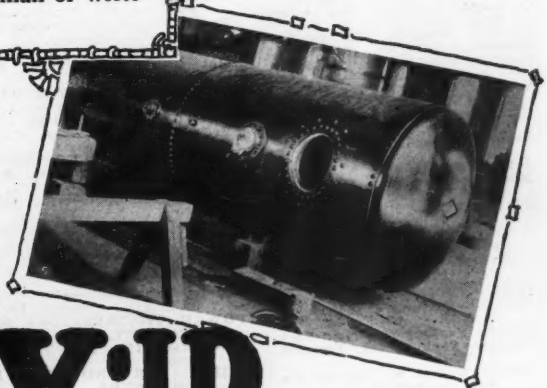

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Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

OIL PURIFIERS
De Laval Steam Turbine Co., Trenton, N. J.
Nugent & Co., Wm. W., Chicago, Ill.

OIL SEPARATORS.
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., New York.
Nugent & Co., Wm. W., Chicago, Ill.
Wright-Austin Co., Detroit.

OIL TANKS.
Manzel Bros. Co., Buffalo, N. Y.
Nugent & Co., Wm. W., Chicago, Ill.

OILING SYSTEMS.
Burt Mfg. Co., The, Akron, O.
Hills-McCanna Co., Chicago, Ill.
Nugent & Co., Wm. W., Chicago, Ill.

OILS, LUBRICATING.
Cook's Sons, Inc., Adam, New York, N. Y.
Dearborn Chemical Co., Chicago.
Standard Oil Co. (Indiana), Chicago, Ill.
Vacuum Oil Co., New York.

PACKING, ASBESTOS.
Crandall Packing Co., Palmyra.
Garlock Packing Co., Palmyra, N. Y.
United States Rubber Co., New York.

PACKING, CENTRIFUGAL PUMP.
Conneaut Packing Co., Conneaut, O.
Garlock Packing Co., Palmyra, N. Y.
United States Rubber Co., New York, N. Y.

PACKING, METALLIC.
Conneaut Packing Co., The, Conneaut, O.
Crandall Packing Co., Palmyra, N. Y.
Crane Packing Co., Chicago, Ill.
Eureka Packing Co., New York.
Garlock Packing Co., Palmyra, N. Y.
Holmes Metallic Packing Co., Wilkes-Barre, Pa.
Power Specialty Co., New York.

PACKING, METALLIC FOR CONDENSER TUBES.
Crane Packing Co., Chicago, Ill.

PACKING, PISTON AND ROD.
Conneaut Packing Co., Conneaut, O.
Crane Packing Co., Chicago, Ill.
Eureka Packing Co., New York.
Garlock Packing Co., Palmyra, N. Y.
Goetze Gasket & P'k'g. Co., New Brunswick, N. J.
Goodyear Tire & Rubber Co., Inc., The, Akron, O.
Greene, Tweed & Co., New York.
Johns-Manville, Inc., New York.
New York Belting & P'k'g. Co., New York.
Pioneer Rubber Mills, San Francisco, Calif.
Quaker City Rubber Co., Philadelphia.
United States Rubber Co., New York, N. Y.

PACKING, SHEET.
Crandall Packing Co., Palmyra, N. Y.
Eureka Packing Co., New York.
Garlock Packing Co., Palmyra, N. Y.
Goetze Gasket & Packing Co., New Brunswick, N. J.
Goodyear Tire & Rubber Co., Inc., The, Akron, O.
Jenkins Bros., New York, N. Y.
Johns-Manville, Inc., New York.
New York Belting & P'k'g. Co., New York.
Pioneer Rubber Mills, San Francisco, Calif.
Quaker City Rubber Co., Philadelphia.
Robertson & Sons, Jas. L., New York.
United States Rubber Co., New York, N. Y.

PACKING, VALVE STEM.
Conneaut Packing Co., Conneaut, O.
Crandall Packing Co., Palmyra, N. Y.
Garlock Packing Co., Palmyra, N. Y.
Johns-Manville, Inc., New York.
New York Belting & P'k'g. Co., New York.
Quaker City Rubber Co., Philadelphia.
United States Rubber Co., New York, N. Y.

PAINT, ANTI-CORROSIVE.
Wailes Dove-Hermiston Corp., New York.

PAINT, FLOOR.
Wailes Dove-Hermiston Corp., New York.

PAINT, GRAPHITE.
Dixon Crucible Co., Jos., Jersey City, N. J.

PAINT, HEAT RESISTING.
Wailes Dove-Hermiston Corp., New York.

PAINT, PROTECTIVE.
Wailes Dove-Hermiston Corp., New York.

PIPE BENDING.
National Pipe Bending Co., The, New Haven, Conn.
National Valve & Mfg. Co., Pittsburgh.
Pittsburgh Piping & Equipment Co., Pittsburgh, Pa.

PIPE COILS.
National Pipe Bending Co., The, New Haven, Conn.
Power Piping Co., Pittsburgh.
Superheater Co., The, New York.

PIPE COVERINGS.
American District Steam Co., N. Tonawanda, N. Y.
Carey Co., The Philip, Cincinnati.
Johns-Manville, Inc., New York.

PIPE CUTTERS.
Hall-Will, Inc., Erie, Pa.
Toledo Pipe Threading Mach. Co., The, Toledo, O.
Williams Tool Corp., Erie, Pa.

PIPE THREADING MACHINES.
Hall-Will, Inc., Erie, Pa.
Toledo Pipe Threading Mach. Co., The, Toledo, O.
Williams Tool Corp., Erie, Pa.

PIPE, WOOD.
American District Steam Co., N. Tonawanda, N. Y.

PIPE, WROUGHT STEEL.
National Tube Co., Pittsburgh.
Reading Iron Co., Reading, Pa.

PIPING.
Baker Co., Inc., R. H., Cambridge, Mass.
Byers Co., A. M., Pittsburgh.
National Tube Co., Pittsburgh.
National Valve & Mfg. Co., Pittsburgh.
Pittsburgh Valve, Fdry. & Construction Co., Pittsburgh.
Power Piping Co., Pittsburgh.
Reading Iron Co., Reading, Pa.
Walsh & Weidner Boiler Co., The, Chattanooga, Tenn.

PIPING CONTRACTING MANUFACTURERS.
Baker Co., Inc., R. H., Cambridge, Mass.
Byers Co., A. M., Pittsburgh.
National Valve & Mfg. Co., Pittsburgh, Pa.
Pittsburgh Piping & Equipment Co., Pittsburgh, Pa.
Pittsburgh Valve, Fdry. & Construction Co., Pittsburgh.
Power Piping Co., Pittsburgh.
Pope, Wm. A., Chicago.

PLANIMETERS.
Robertson & Sons, Jas. L., New York.

PLATE STEEL CONSTRUCTION.
Littleford Bros., Cincinnati.

PORTABLE CONVEYORS.
Jeffrey Mfg. Co., The, Columbus, O.

POWDERED COAL EQUIPMENT
Bethlehem Steel Co., Inc., Bethlehem, Pa.
Combustion Engineering Corp., New York, N. Y.
Fuller-Lehigh Co., Fullerton, Pa.
Furnace Engineering Co., New York.

POWER SHOWS.
Midwestern Engineering Exposition, Inc., Chicago, Ill.

POWER TRANSMITTING MACHINERY.
Webster Mfg. Co., The, Chicago.

PREHEATER AND HEAT EXCHANGERS.
Patterson-Kelley Co., The, New York.

PREHEATING APPARATUS.
Air Preheater Corp., The, New York.
Babcock & Wilcox Co., The, New York.
New York Blower Co., Chicago.

PRIMERS, PUMP.
Blackburn-Smith Corp., The, New York.

PULLEY, FRICTION CLUTCH.
Link-Belt Co., Chicago, Ill.

PULVERIZED FUEL EQUIPMENT.
Combustion Engineering Corp., New York.
Fuller-Lehigh Co., Fullerton, Pa.
Riley Stoker Corp., Worcester, Mass.

PULVERIZERS, COAL.
American Pulverizer Co., St. Louis.
Bethlehem Steel Co., Inc., Bethlehem, Pa.
Combustion Eng'r'g Corp., New York.
Fuller-Lehigh Co., Fullerton, Pa.
Furnace Engineering Co., New York.
Jeffrey Mfg. Co., The, Columbus.
Pennsylvania Crusher Co., Philadelphia.
Riley Stoker Corp., Worcester.
Williams Patent Crusher & Pulverizer Co., St. Louis, Mo.

PULVERIZERS, LIMESTONE.
Pennsylvania Crusher Co., Philadelphia.

PUMPING SYSTEMS, AIR LIFT.
Ingersoll-Rand Co., New York.

PUMPS, BOILER FEED.
American Steam Pump Co., Battle Creek, Mich.
Bethlehem Shipbuilding Corp., Bethlehem, Pa.
Buffalo Forge Co., Buffalo.
Coppus Engineering Corp., Worcester, Mass.
Dean Bros. Co., Indianapolis.
Dean Hill Pump Co., Anderson, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
Fairbanks, Morse & Co., Chicago.
Gardener Governor Co., The, Quincy, Ill.
Ingersoll-Rand Co. (Cameron Steam Pump Wks., A. S.), New York.
Kingsford Fdry. & Mach. Wks., Oswego, N. Y.
Lecourtenay Co., Newark, N. J.
Manistee Iron Works, Manistee.
Moore Steam Turbine Corp., Wellsville, N. Y.
Platt Iron Works, Dayton, O.
Superheater Co., The, New York.
Warren Steam Pump Co., Inc., Warren, Mass.
Worthington Pump & Machinery Corp., New York, N. Y.

PUMPS, CENTRIFUGAL.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Steam Pump Co., Battle Creek, Mich.
Bethlehem Shipbuilding Corp., Bethlehem, Pa.
Coppus Engineering Corp., Worcester, Mass.
Dean Hill Pump Co., Anderson, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
Fairbanks, Morse & Co., Chicago.
Ingersoll-Rand Co. (Cameron Steam Pump Wks., A. S.), New York.
Kingsford Fdry. & Mach. Wks., Oswego, N. Y.
Lecourtenay Co., Newark, N. J.
Manistee Iron Works, Manistee.
Moore Steam Turbine Corp., Wellsville, N. Y.
Northern Equipment Co., Erie.
Platt Iron Works, Dayton, O.
Taber Pump Co., Buffalo.
Terry Steam Turbine Co., Hartford, Conn.
Warren Steam Pump Co., Inc., Warren, Mass.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.
Worthington Pump & Machinery Corp., New York, N. Y.
Yeomans Bros. Co., Chicago, Ill.

PUMPS, DEEP WELL.
American Steam Pump Co., Battle Creek, Mich.
Fairbanks, Morse & Co., Chicago.
Lecourtenay Co., Newark, N. J.
Northern Equipment Co., Erie.
Platt Iron Works, Dayton, O.

PUMPS, ELECTRIC
American Steam Pump Co., Battle Creek, Mich.
Dean Bros. Co., Indianapolis.
Gardner Governor Co., The, Quincy, Ill.
Platt Iron Works, Dayton, O.
Warren Steam Pump Co., Inc., Warren, Mass.
Yeomans Bros. Co., Chicago, Ill.

PUMPS, ELEVATOR AND FIRE.
American Steam Pump Co., Battle Creek, Mich.
Dean Bros. Co., Indianapolis.
De Laval Steam Turbine Co., Trenton, N. J.
Lecourtenay Co., Newark, N. J.
Manistee Iron Works, Manistee, Mich.
Warren Steam Pump Co., Inc., Warren, Mass.
Yeomans Bros. Co., Chicago.

PUMPS, GENERAL SERVICE.
Buffalo Steam Pump Co., Buffalo, N. Y.

PUMPS, HYDRAULIC PRESSURE.
American Steam Pump Co., Battle Creek, Mich.
Dean Bros. Co., Indianapolis.
Platt Iron Works, Dayton, O.
Warren Steam Pump Co., Inc., Warren, Mass.

PUMPS, JET.
Elliott Co., Jeannette, Pa.
Manistee Iron Works, Manistee, Mich.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

PUMPS, OIL.
Bethlehem Shipbuilding Corp., Ltd., Bethlehem, Pa.
Gardner Governor Co., The, Quincy, Ill.
Lonergan Co., J. E., Philadelphia.
Manzel Bros. Co., Buffalo, N. Y.
Nugent & Co., Wm. W., Chicago, Ill.
Penberthy Injector Co., Detroit.
Warren Steam Pump Co., Inc., Warren, Mass.

PUMPS, POWER.
American Steam Pump Co., Battle Creek, Mich.
Bethlehem Shipbuilding Corp., Bethlehem, Pa.
Fairbanks, Morse & Co., Chicago.
Gardner Governor Co., The, Quincy, Ill.
Lecourtney Co., Newark, N. J.
Platt Iron Works, Dayton, O.
Warren Steam Pump Co., Inc., Warren, Mass.
Worthington Pump & Machinery Corp., New York, N. Y.

PUMPS, ROTARY.
Lecourtney Co., Newark, N. J.
Manistee Iron Works, Manistee, Mich.
Platt Iron Works, Dayton, O.
Taber Pump Co., Buffalo.

PUMPS, STEAM.
Dean Hill Pump Co., Anderson, Ind.

PUMPS, TURBINE.
Bethlehem Shipbuilding Corp., Bethlehem, Pa.
Moore Steam Turbine Corp., Wellsville, N. Y.

PUMPS, VACUUM.
Allen & Billmyre Co., Inc., New York.
American Steam Pump Co., Battle Creek, Mich.
Dean Bros. Co., Indianapolis.
Gardner Governor Co., The, Quincy, Ill.
Ingersoll-Rand Co., New York.
Lecourtney Co., Newark, N. J.
Manistee Iron Works, Manistee, Mich.
Warren Steam Pump Co., Inc., Warren, Mass.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

PUMPS, WATERWORKS.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Steam Pump Co., Battle Creek, Mich.
Bethlehem Steel Co., Inc., Bethlehem, Pa.
Fairbanks, Morse & Co., Chicago.
Gardner Governor Co., The, Quincy, Ill.
Lecourtney Co., Newark, N. J.
Manistee Iron Works, Manistee.
Moore Steam Turbine Corp., Wellsville, N. Y.
Murray Iron Works Co., Burlington, Iowa.
Platt Iron Works, Dayton, O.
Terry Steam Turbine Co., Hartford, Conn.
Warren Steam Pump Co., Inc., Warren, Mass.

PURIFIERS, BOILER FEED.
Cochrane Corp., Philadelphia.
Hoppes Mfg. Co., Springfield, O.
Sims Co., The, Erie, Pa.

PURIFIERS, STEAM.
Andrews-Bradshaw Co., The, Pittsburgh.

PYROMETERS.
Bristol Co., The, Waterbury.
Brown Instrument Co., The, Philadelphia, Pa.
Republic Flow Meters Co., Chicago, Ill.
Taglilabue Mfg. Co., C. J., Brooklyn.
Taylor Inst. Co.'s, Rochester,
Uehling Instrument Co., Paterson, N. J.

QUENCHERS, ASH.
Allen-Sherman-Hoff Co., The, Philadelphia, Pa.

RECORDERS, LIQUID LEVEL.
Bristol Co., The, Waterbury.
Brown Instrument Co., The, Philadelphia, Pa.

RECORDING INSTRUMENTS.
Bacharach Ind. Instrument Co., Pittsburgh, Pa.
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Brown Instrument Co., The, Philadelphia, Pa.
Simplex Valve & Meter Co., Philadelphia.
Taylor Inst. Co.'s, Rochester,
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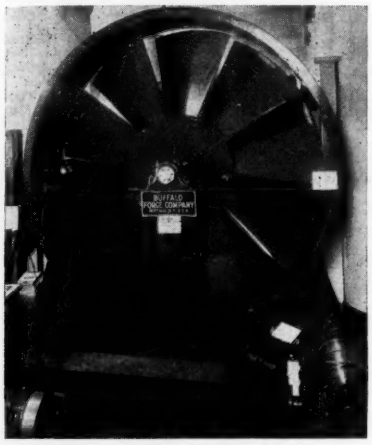

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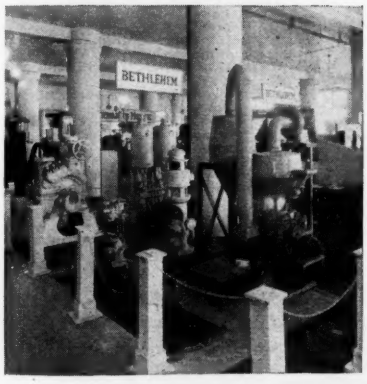

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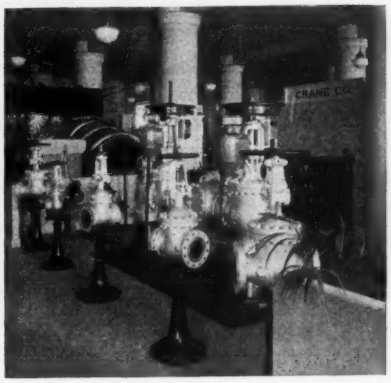

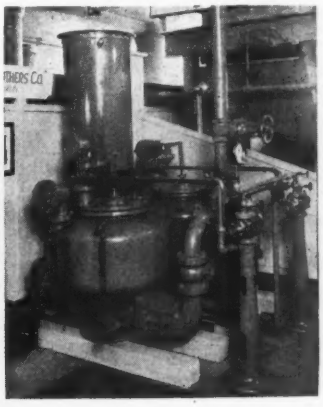

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Pittsburgh Valve, Fdry. & Construction Co., Pittsburgh.
Robertson & Sons, J. L., N. Y.
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Allen-Sherman-Hoff Co., The, Philadelphia, Pa.

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Diamond Power Spec. Corp., Detroit, Mich.
Huyette Co., Inc., The Paul B., Philadelphia, Pa.
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Cooling Tower Co., Inc., The, New York, N. Y.

SPRAY COOLING SYSTEMS.
Binks Spray Equip. Co., Chicago, Ill.
Buffalo Forge Co., Buffalo.
Cooling Tower Co., Inc., The, New York, N. Y.
Power Plant Equipment Co., Kansas City, Mo.

SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford, Mass.

STACKS, METAL.
Littleford Bros., Cincinnati, O.

STAIR TREAD, ANTI-SLIP.
Irving Iron Works Co., Long Island City, N. Y.
Scully Steel & Iron Co., Chicago.

STEAM TRAPS.
American District Steam Co., N. Tonawanda, N. Y.
Armstrong Machine Wks., Three Rivers, Mich.
Bundy Steam Trap Co., Nashua.
Cochrane Corp., Philadelphia.
Davis Regulator Co., G. M., Chicago, Ill.
Fisher Governor Co., Inc., The, Marshalltown, Iowa.
Golden-Anderson Valve Specialty Co., Pittsburgh.
Illinois Engineering Co., Chicago.
Johns-Manville, Inc., New York.
Locke Regulator Co., Salem, Mass.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Patterson-Kelley, New York.
Powers Regulator Co., Chicago.
Sarco Company, Inc., New York.
"S-C" Regulator Mfg. Co., The, Fostoria, Ohio.
Squires Co., The C. E., Cleveland, Ohio.
Strong, Carlisle & Hammond Co., Cleveland, Ohio.
Williams Valve Co., D. T., Cincinnati, Ohio.
Wright-Austin Co., Detroit.
Yarnall-Waring Co., Philadelphia, Pa.

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Allis-Chalmers Mfg. Co., Milwaukee, Wis.
De Laval Steam Turbine Co., Trenton, N. J.
Elliott Co., Jeannette, Pa.
Moore Steam Turbine Co., Wellsville, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford, Conn.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Wing Mfg. Co., L. J., New York.

STOCKS AND DIES.
Toledo Pipe Threading Mach. Co., The, Toledo, O.

STOKERS, CHAIN GRATE.
Babcock & Wilcox Co., The, New York, N. Y.
Burke Engineering Co., Holland, Mich.
Combustion Eng'r'g Corp., New York.
Laclede Stoker Co., St. Louis.
Riley Stoker Corp., Worcester,

STOKERS, FORCED DRAFT.
Flynn & Emrich Co., Baltimore.

STOKERS, HAND OPERATED.
Armstrong Mfg. Co., Springfield, Ohio.
Burke Engineering Co., Holland, Mich.
Flynn & Emrich Co., Baltimore.
Hofft Co., The M. A., Indianapolis, Ind.
Kelly Foundry & Mach. Co., The, Goshen, Ind.
Marion Mach. Fdr'y & Supply Co., Marion, Ind.

STOKERS, HOPPER FED.
Flynn & Emrich Co., Baltimore.

STOKERS, MECHANICAL.
American Eng'r'g Co., Phila.
Armstrong Mfg. Co., Springfield, Ohio.
Babcock & Wilcox Co., The, New York.
Burke Engineering Co., Holland, Mich.
Combustion Eng'r'g Corp., New York.
Detroit Stoker Co., Detroit.
Flynn & Emrich Co., Baltimore.
Hart Stoker, Ltd., The, Philadelphia, Pa.
Hofft Co., The M. A., Indianapolis, Ind.
Riley Stoker Corp., The, Worcester, Mass.
Sturtevant Co., B. F., Hyde Park, Mass.

STOKERS, OVERFEED AND UNDERFEED.
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Combustion Eng'r'g Corp., New York.
Detroit Stoker Co., Detroit.
Flynn & Emrich Co., Baltimore.
Hart Stoker, Ltd., The, Philadelphia, Pa.
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Riley Stoker Corp., The, Worcester, Mass.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

STRAINERS.
Andale Engineering Co., Phila.
Blackburn-Smith Corp., The, New York.
Davis Regulator Co., G. M., Chicago.
Dean Bros. Co., Indianapolis.
Elliott Company, Jeannette, Pa.
Ross Heater & Mfg. Co., Buffalo.
Sarco Co., Inc., New York.
Wright-Austin Co., Detroit.

STRAINERS, OIL.
Bethlehem Shipbuilding Corp., Bethlehem, Pa.
Blackburn-Smith Corp., The, New York.
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., New York.
Ross Heater & Mfg. Co., Buffalo.
Sarco Co., Inc., New York.

STRUCTURAL STEEL.
Bethlehem Steel Co., Inc., Bethlehem, Pa.

SUPERHEATER, STEAM.
Babcock & Wilcox Co., The, New York.
Badenhausen Corp., Cornwells Heights, Pa.
Heine Boiler Co., St. Louis.
Power Plant Equipment Co., Kansas City, Mo.
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SWITCHBOARDS
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SWITCHBOARDS, ASBESTOS.
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SWITCHES.
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TACHOMETERS.
Bristol Co., The, Waterbury.
Brown Instrument Co., The, Philadelphia, Pa.

TANKS.
Brady Conveyors Corp., Chicago.
Heine Boiler Co., St. Louis.
Littleford Bros., Cincinnati, O.
Murray Iron Works Co., Burlington, Iowa.
Sims Co., The, Erie, Pa.
Springfield Boiler Co., Springfield, Ill.
Walsh & Weidner Boiler Co., The, Chattanooga, Tenn.

TELESCOPIC OILERS
Nugent & Co., Wm. W., Chicago, Ill.

THERMOMETERS.
Bristol Co., The, Waterbury.
National Regulator Co., Chicago.
Power Specialty Co., New York.
Powers Regulator Co., The, Chicago, Ill.
Tagliabue Mfg. Co., C. J., Brooklyn.
Taylor Inst. Co.'s, Rochester,

THERMOMETERS, RECORDING AND INDICATING.
Bristol Co., The, Waterbury.
Brown Instrument Co., The, Philadelphia, Pa.
Taylor Inst. Co.'s, Rochester,

TOOLS AND SUPPLIES.
Hall-Will, Inc., Erie, Pa.
Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Williams Tool Corp., Erie, Pa.

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TRANSMISSION ROPE.
American Steel & Wire Co., Chicago and New York.

TRAPS, COMPRESSED AIR.
Armstrong Machine Wks., Three Rivers, Mich.
Nicholson & Co., W. H., Wilkes-Barre, Pa.

TRAPS, RADIATOR.
Armstrong Machine Wks., Three Rivers, Mich.
Sarco Co., Inc., New York.
Strong, Carlisle & Hammond Co., Cleveland, Ohio.

TRAPS, RETURN
Bundy Steam Trap Co., Nashua.
Kieley & Mueller, Inc., New York, N. Y.
Sarco Co., Inc., New York.

TRAPS, STEAM AND RADIATOR.
Illinois Engineering Co., Chicago.
Sarco Co., Inc., New York.

TRAPS, VACUUM.
Armstrong Machine Wks., Three Rivers, Mich.
Bundy Steam Trap Co., Nashua.
Strong, Carlisle & Hammond Co., Cleveland, Ohio.

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Wellman-Seaver-Morgan Co., The, Cleveland, O.

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Lagonda Mfg. Co., Springfield, Ohio.
Scully Steel & Iron Co., Chicago.

TUBING.
Babcock & Wilcox Tube Co., The, Beaver Falls, Pa.
Byers Co., A. M., Pittsburgh.
National Tube Co., Pittsburgh.
Scully Steel & Iron Co., Chicago.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

TUBING, SEAMLESS STEEL.
National Tube Co., Pittsburgh.

TURBINES, HYDRAULIC.
De Laval Steam Turbine Co., Trenton, N. J.
Worthington Pump & Machinery Corp., New York.

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UNIONS.
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Continental Valve & Equip. Co., Framingham, Mass.
Dart Mfg. Co., E. M., Providence, R. I.

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Kennedy Valve Mfg. Co., Elmira.
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VALVES.
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Golden-Anderson Valve Specialty Co., Pittsburgh.
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VALVES, AUTOMATIC CUT-OFF.
Elliott Co., Jeannette, Pa.
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Davis Regulator Co., G. M., Chicago, Ill.
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Locke Regulator Co., Salem, Mass.
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Powell Co., Wm., Cincinnati, O.
Scully Steel & Iron Co., Chicago.

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Golden-Anderson Valve Specialty Co., Pittsburgh.
Homestead Valve Mfg. Co., Homestead, Pa.
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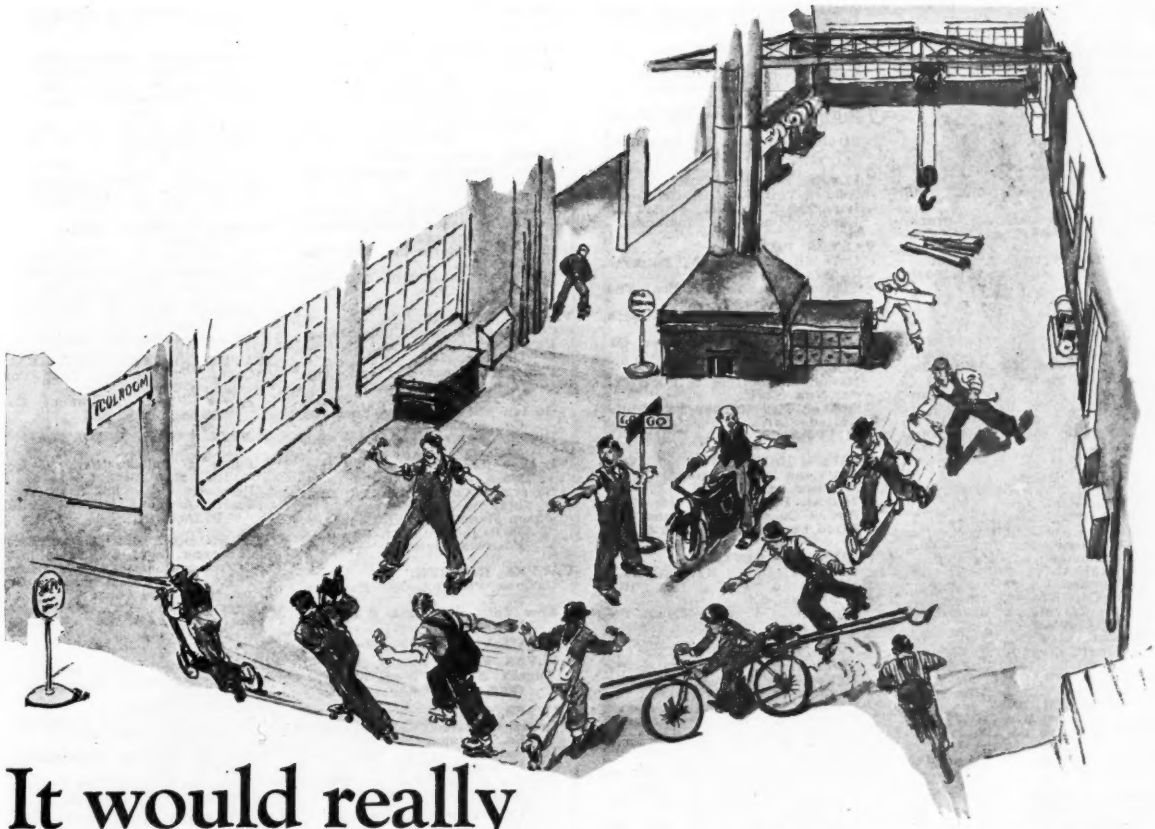

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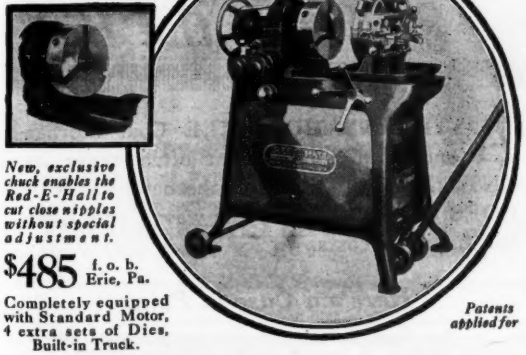

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Powell Co., Wm., Cincinnati, O.
Schutte & Koerting Co., Philadelphia.
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VALVES, FLOAT.
Atlas Valve Co., Newark, N. J.
Davis Regulator Co., G. M., Chicago, Ill.
Fisher Governor Co., Inc., The, Marshalltown, Iowa.
Foster Engineering Co., Newark.
Illinois Engineering Co., Chicago.
Mason Regulator Co., Boston.
Yarnall - Waring Co., Philadelphia, Pa.

VALVES, GATE.
Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., Elmira.
Lunkenheimer Co., Cincinnati.
National Valve & Mfg. Co., Pittsburgh, Pa.
Pittsburgh Valve, Fdry. & Construction Co., Pittsburgh.
Powell Co., Wm., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, Ohio.

VALVES, GLOBE.
Homestead Valve Mfg. Co., Homestead, Pa.
Jenkins Bros., New York, N. Y.
Kennedy Valve Mfg. Co., Elmira.
Locke Regulator Co., Salem.
Lunkenheimer Co., Cincinnati.
Pittsburgh Valve, Fdry. & Construction Co., Pittsburgh.
Powell Co., Wm., Cincinnati, O.
Strong, Carlisle & Hammond Co., Cleveland, Ohio.
Williams Valve Co., D. T., Cincinnati, O.

VALVES, HYDRAULIC.
Homestead Valve Mfg. Co., Homestead, Pa.
Kennedy Valve Mfg. Co., Elmira.
Williams Valve Co., D. T., Cincinnati, O.
Yarnall - Waring Co., Philadelphia, Pa.

VALVES, NON-RETURN.
Davis Regulator Co., G. M., Chicago, Ill.
Elliott Co., Jeannette, Pa.
Foster Engineering Co., Newark.
Golden-Anderson Valve Specialty Co., Pittsburgh.
Illinois Engineering Co., Chicago.
Lunkenheimer Co., Cincinnati.
Ruggles - Klingemann Mfg. Co., Salem, Mass.
Schutte & Koerting Co., Philadelphia.
Strong, Carlisle & Hammond Co., Cleveland, Ohio.

VALVES, POP SAFETY
Ashton Valve Co., Boston, Mass.
Lonergan Co., J. E., Phila., Pa.
Lunkenheimer Co., Cincinnati.

VALVES, PUMP.
Crandall Packing Co., Palmyra, N. Y.
Fisher Governor Co., Inc., The, Marshalltown, Iowa.
Garlock Packing Co., Palmyra, N. Y.
Goodyear Tire & Rubber Co., Inc., Akron, O.
Jenkins Bros., New York, N. Y.
New York Belting & P'k'g Co., New York.
Quaker City Rubber Co., Phila.
United States Rubber Co., New York, N. Y.

VALVES, RADIATOR.
American District Steam Co., N. Tonawanda, N. Y.
Jenkins Bros., New York, N. Y.
Powell Co., Wm., Cincinnati, O.
Sarco Co., Inc., New York.

VALVES, REDUCING.
Atlas Valve Co., Newark, N. J.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Continental Valve & Equip. Co., Framingham, Mass.
Davis Regulator Co., G. M., Chicago, Ill.
Elliott Company, Jeannette, Pa.
Fisher Governor Co., Inc., The, Marshalltown, Iowa.
Foster Engineering Co., Newark.
Golden-Anderson Valve Specialty Co., Pittsburgh.
Illinois Engineering Co., Chicago.
Locke Regulator Co., Salem, Mason Regulator Co., Boston.
National Regulator Co., Chicago.
Ruggles - Klingemann Mfg. Co., Salem, Mass.
Powers Regulator Co., Chicago.
Squires Co., C. E., Cleveland, O.

VALVES, REGRINDING.
Homestead Valve Mfg. Co., Homestead, Pa.
Mason Regulator Co., Boston.
Penberthy Injector Co., Detroit.
Williams Valve Co., D. T., Cincinnati, Ohio.

VALVES, REGULATING.
Atlas Valve Co., Newark, N. J.
Davis Regulator Co., G. M., Chicago.
Foster Engineering Co., Newark.
Golden-Anderson Valve Specialty Co., Pittsburgh.
Powers Regulator Co., The, Chicago, Ill.
"S-C" Regulator Mfg. Co., The, Fostoria, Ohio.

VALVES, RELIEF.
Cochrane Corp., Philadelphia.
Davis Regulator Co., G. M., Chicago.
Fisher Governor Co., Inc., The, Marshalltown, Iowa.
Foster Engineering Co., Newark.
Golden-Anderson Valve Specialty Co., Pittsburgh.
Illinois Engineering Co., Chicago.
Locke Regulator Co., Salem, Mass.
Lonergan Co., J. E., Philadelphia, Pa.
Mason Regulator Co., Boston.
"S-C" Regulator Mfg. Co., The, Fostoria, Ohio.

VALVES, RUBBER.
Garlock Packing Co., Palmyra, N. Y.
New York Belting & P'k'g Co., New York.
Quaker City Rubber Co., Phila.

VALVES, SIGHT FEED.
Nugent & Co., Wm. W., Chicago, Ill.

VALVES, STOP.
Golden-Anderson Valve Specialty Co., Pittsburgh.
Homestead Valve Mfg. Co., Homestead, Pa.
Schutte & Koerting Co., Philadelphia.

VALVES, STOP AND CHECK.
Golden-Anderson Valve Specialty Co., Pittsburgh.

VALVES, THREE & FOUR WAY.
Nicholson & Co., W. H., Wilkes-Barre, Pa.

VENTILATING APPARATUS.
Buffalo Forge Co., Buffalo.
Burt Mfg. Co., The, Akron, O.
Coppus Engineering Corp., Worcester, Mass.
New York Blower Co., Chicago.
Sturtevant Co., B. F., Hyde Park, Mass.
Wing Mfg. Co., L. J., New York.

WALKWAYS, OPEN STEEL.
Irving Iron Works Co., Long Island City, N. Y.

WATER COLUMNS AND ALARMS.
Keckley Co., O. C., Chicago, Ill.
Lunkenheimer Co., Cincinnati.
Reliance Gauge Column Co., The, Cleveland, O.
Williams Gauge Co., The, Pittsburgh.
Wright-Austin Co., Detroit.

WATER COOLING EQUIPMENT.
Cooling Tower Co., Inc., The, New York.
Power Plant Equipment Co., Kansas City, Mo.

WATER PURIFYING APPARATUS.
Paige & Jones Chemical Co., Inc., New York.
Permutit Co., The, New York.
Scaife & Sons Co., Wm. B., Pittsburgh.

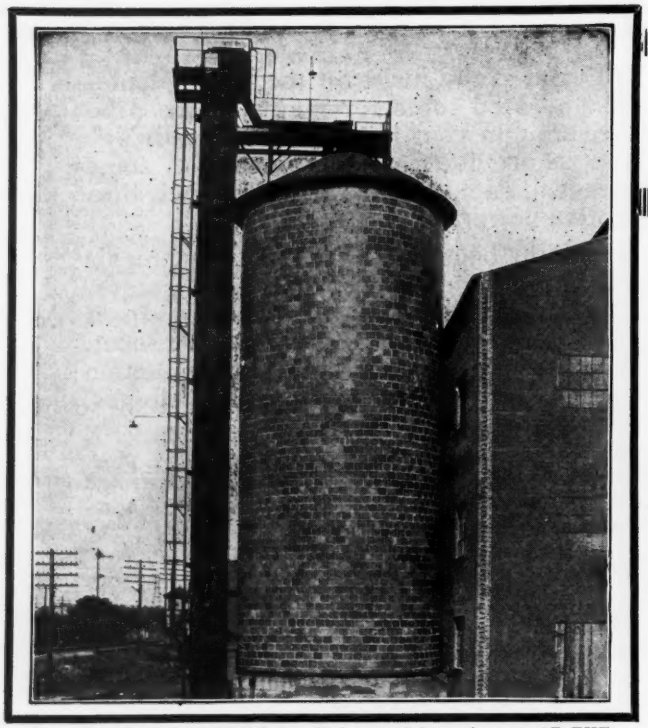
WATER SOFTENING SYSTEMS.
Cochrane Corp., Philadelphia.
Dearborn Chemical Co., Chicago.
Paige & Jones Chemical Co., Inc., New York.
Permutit Co., The, New York.
Scaife & Sons Co., Wm. B., Pittsburgh.

WHISTLES.
Lonergan Co., J. E., Phila.
Powell Co., Wm., Cincinnati, O.

WIRE BRUSHES.
Pilley Pkg. & Flue Brush Mfg. Co., St. Louis, Mo.

WIRE OF EVERY DESCRIPTION.
American Steel & Wire Co., Chicago and New York.

WIRE ROPE AND FITTINGS.
American Steel & Wire Co., Chicago and New York.



This STEARNS HOLOTILE Installation saved its entire cost AT THE START. It's been cutting OPERATING costs ever since.

Saved Its Cost "Right off the Bat"

A STEARNS-HOLOTILE Coal Storage and Handling System often saves its ENTIRE COST "right off the bat." Then it GOES ON SAVING by the way it cuts labor and handling costs.

Here's a Case in Point

As originally planned, this boiler-house (at the Lambert Tire & Rubber Co., Barberton, Ohio) was to have the ordinary internal overhead bins for coal storage. By using this STEARNS-HOLOTILE Storage and Reclaiming System, however, their engineers discovered that enough could be saved through the consequent reduction in building height to pay for the entire cost of the STEARNS-HOLOTILE installation — and that it permanently simplified the handling problem as well.

Ask for New Bulletin 106-D

The Stearns Conveyor Co., (*Owned by Chain-Belt Co.*)

Main Office and Works: St. Clair Avenue at East 200th Street, CLEVELAND, OHIO

Branches in New York City, Buffalo, Milwaukee, Los Angeles, San Francisco, Chicago, Detroit, St. Louis, Portland, Ore., Philadelphia, Pittsburgh, Minneapolis, etc.

If you are now threading pipe by the RAPIDUCTION method

you already know

—that the Williams RAPIDUCTION gives you threads three times as fast—and at lower cost.

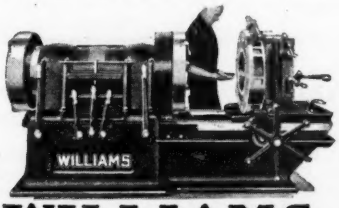
You know that a complete set of chaser bits for the RAPIDUCTION weighs only 8 pounds—**or 136 pounds less** than those used by old type machines.

Inexpensive chaser bits—easily handled—individually replaced. If you snip one, **you renew that one only.** No need for the whole new set that an old-time die head would require. No recutting—ever!

And of course you know that a single die head covers the complete range of the machine—when you're using the RAPIDUCTION.

Write for a full description of the RAPIDUCTION machine.

Williams Tool Corporation **Erie, Pa.**



WILLIAMS RAPIDUCTION POWER PIPE MACHINE

WHEN OTHERS FAIL USE A "TOLEDO"

An 8" water line threaded in a few moments with this "TOLEDO" tool. Portable, compact, and easy to operate, "TOLEDO'S" represent the utmost efficiency in pipe tools.

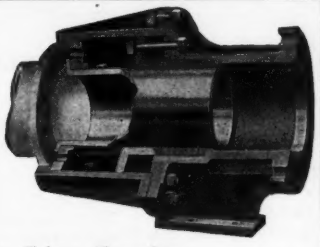
Our catalog will be sent on request.

Insist on a Genuine

"TOLEDO"

THE TOLEDO PIPE THREADING MACHINE CO.
TOLEDO, OHIO
New York Office, 72 Lafayette St.

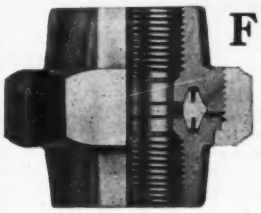
Howard Guided Expansion Joint



For Pipe Line Service

Eliminates trouble from Expansion and Contraction, saves space, labor and repair bills; the construction is mechanically correct.

ALBERGER HEATER CO. **285 Chicago St.**
HOWARD IRON WORKS **Buffalo, N. Y.**



Framanco Screw End Union showing renewable tapered joint—tight after many times making and breaking.

FRAMANCO

Trouble-Proof

FORGED STEEL Fittings, Flanged and Boxed Unions

Made only by the

Continental Valve & Equipment Co.

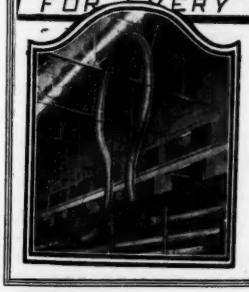
Sales Offices and Works:
82 Herbert St., Framingham, Mass.

Chicago Office:
80 East Jackson Blvd.

Write for Full Information

Power Piping

FOR EVERY INDUSTRIAL NEED



No Matter What!

This company is serving many public utility corporations and private power plants with a splendid record of service and satisfaction wherever POWER PIPING installations have been made. We welcome inquiries on any problem, no matter what complications may be involved. Make your problem OURS by telling us what it is!

POWER PIPING COMPANY
829 Beaver Ave., N. S.,
Pittsburgh, Pa.

R. H. BAKER COMPANY INCORPORATED

Cambridge, Massachusetts

Steam Power Plant

ECONOMY · INTEGRITY · SPEED · WORKMANSHIP
R. H. BAKER COMPANY INC.

and Industrial Piping

Complete Systems

SIGNBOARD SECTION

Quick Action Opportunities

CLASSIFIED RATES

Advertisements in the Signboard Section which come under the classification "Position Wanted," "Help Wanted," "Salesmen and Agencies," "Business Opportunities," "Patent and Patent Attorneys" and "Technical Books" will be set in type as shown below and published at the rate of

50 cents a line

each insertion, 6 words to a line; minimum sold, 4 lines.

For display of any advertisement under the classified headings see sizes and rates in column at right.

DISPLAY RATES

Advertisements in Signboard Section which come under the classification "Equipment for Sale," "Equipment Wanted," "Educational and Instruction," and "Miscellaneous" are set in display space of the following sizes and at these rates:

1 in.	$ 5.50	4 in.	$20.80
2 in.	10.80	1 col. (8½ in.)	43.35
3 in.	15.90	2 col. (17 in.)	85.00

Not less than one inch to be sold in these classifications.

For advertising rates under other headings in this section, see column at left.

POSITIONS WANTED

Position Wanted—By engineer with 15 years' experience. Has broad knowledge of plant management. 36 years. Married. Will go anywhere. Address Box 876, POWER PLANT ENGINEERING, 53 W. Jackson Blvd., Chicago, Ill.

SALESMEN AND AGENCIES

Manufacturers' Agents Take Notice. The firm of W. H. Nicholson & Co., Wilkes-Barre, Pa., manufacturers of the well known line of Nicholson steam specialties, including the piston operated super trap, separators, four-way valves, etc., desires to place the exclusive agency of these specialties in the following cities: Chicago, St. Louis, Indianapolis, Minneapolis, Knoxville, Nashville, Little Rock, Duluth, and Syracuse, N. Y. If interested, advise the lines you are now handling and the territory you can advantageously cover and will send you our proposition.

WANTED—Sales engineers with boiler treatment experience. Exclusive territories are available. Liberal commissions. Address Box 880, Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

STEAM SPECIALTY SALESMAN wanted to represent us in open territory. Good commissions. FRANCE PACKING COMPANY, 6512 State Road, Tacony, Philadelphia, Pa.

Mechanical engineer established 20 years as exclusive New York sales agent for manufacturers of pumps, power plant and mechanical equipment, desires additional lines of well advertised equipment of real merit. Address Box 877, POWER PLANT ENGINEERING, 53 W. Jackson Blvd., Chicago, Ill.

SALESMEN AND AGENCIES

WANTED—One new line with merit by live selling organization covering entire Pacific Coast. Our men specialize on equipment for refinery and industrial plants. Address Box 879, Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

HELP WANTED

Assistant Test Engineer Wanted: Prefer young man mechanical engineering graduate with two to four years' experience on power house and power plant efficiency testing. Write Box 882, giving details of experience, age and salary desired. Care POWER PLANT ENGINEERING, 53 West Jackson Blvd., Chicago, Ill.

Large midwestern construction concern is seeking high grade engineer capable of supervising the construction of new factories and power plants. Must thoroughly understand installation of equipment for machine shops and foundries. Prefer man about 35 years old who has had experience in engineering department of concerns who are contracting for the installation of manufacturing plants. Location in central Indiana. Position permanent. State previous experience and salary desired. Address Box 881, Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

A company located in the central west has opening for two erecting engineers of heavy machinery. Piping experience necessary. Give experience in first letter. Address Box 873, Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

BUSINESS OPPORTUNITIES

Will sell outright or on a royalty basis a patented three-in-one valve. A splendid opportunity for specialty manufacturer with proper manufacturing and selling facilities. Embodies three features, ordinary control, check and globe which assure wide usage. Complete details will be furnished on request. Address Box 875, Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

PATENTS AND PATENT ATTORNEYS

A. P. CONNOR, Consulting Electrical and Mechanical Engineer. Attorney-at-law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C.

PATENTS—Booklet free. Highest references. Best results. Send drawing or model for search and report. WATSON E. COLEMAN, Registered Patent Lawyer, 724 9th Street, Washington, D. C.

MISCELLANEOUS

SERVICE TO SUBSCRIBERS—If you want information regarding any kind of power plant apparatus or supplies, write to Subscribers' Service, POWER PLANT ENGINEERING, 53 W. Jackson Blvd., Chicago, Ill., and tell us what you would like. The Service will be glad to give you such informtiaon and put you in touch with manufacturers who can supply your needs.

SIGNBOARD SECTION
Quick Action Opportunities

EQUIPMENT WANTED

WANTED
1—250-hp. Heine Safety Boiler.
1—72-in. x 18-ft. HRT Boiler, 150 lb. pressure.
1—200 to 300-hp. Oil Engine and Generator.
2—Heavy open top cylindrical Tanks about 6 ft. dia. and 12 to 25 ft. high. Prefer with conical bottom. Address Box No. 872
Power Plant Engineering
53 W. Jackson Blvd., Chicago, Ill.

Wanted
300 to 450 K. W. alternating current, direct connected unit, either 2,300 volts with transformers for 220-440 v., or can use straight low voltage set.
Also suitable boilers (ASME) high pressure.
American Emblem Co.
39 Cortlandt St., New York, N. Y.

Use this service to meet your business requirements

The scope of Signboard Section service is wide. That's why it is so successful and why it fits your requirements. Place your message under the classification suited for your particular appeal.

Business Opportunities
Education and Instruction
Equipment For Sale
Equipment Wanted
Help Wanted
Miscellaneous
Proposals and Bids
Patent Attorneys
Patents For Sale
Position Wanted
Salesmen and Agencies
Technical Books

Use the Signboard Section for Quick Action and Results

EQUIPMENT FOR SALE

For Sale: Plant Changed to Electric Drive

Complete power plant.
3—400 hp. Stirling boilers equipped with Green chain grates, coal conveyors, hoppers, boiler feed pumps, heater and stoker engine.
2—11x11x12 Westinghouse air pumps.
1—Steam-driven Vilter ammonia compressor 23x46, Corliss engine 30x48.
2—40-ton Swenson evaporators, complete with condenser, receiver tanks and pumps.
3—Wheeler steam condensers, 560 1-in. brass tubes, 8 ft. long.
2—Wheeler steam condensers, 360 1-in. brass tubes, 8 ft. long.
2—Float valve control pumps 5x5x5 with receiver tank (Dean Steam Pump Company).
2—75 kw., 220 volt, d c. steam-driven Western Electric generators complete with switchboard, meters and circuit breakers.
2—1500 gal. F. M. Prescott centrifugal condenser pumps, direct-connected to 50 hp., 220 v., d. c., 700 r. p. m. Crocker Wheeler motors.
2—1000 gal. Platt Iron Works centrifugal pumps, direct-connected, 35 hp., 220 v., d. c., 1275 r. p. m. Western Electric motors.

Box 878, Power Plant Engineering, 53 W. Jackson Blvd., Chicago

H.R.T. Boilers
3—200 H.P. 150 lb. Pressure ASME. $1100 ea.
2—150 H.P. 150 lb. Pressure ASME. $ 800 ea.
1—200 H.P. 125 lb. Pressure PENN. $ 800

250 Volt D.C. Unit
200 Kw. G. E. dir. con. 20x24 Erie Ball 4 valve engine..... $1500

A.C. Units
400 K.V.A. G. E. 3 Phase 240 Volt dir. con. 22x30 Erie Ball 4 valve engine, with Exciter and Switchboard, complete..... $5750
125 K.V.A. Ridgway 240 Volt dir. con. 14x15 Ridgway engine, Exciter and Switchboard $1850
Turbo-Generator Sets 100 to 1000 K.V.A.

POWER MACHINERY, INC.,
278 Newark Ave. Jersey City, N. J.

Engine Generators, 2 and 3 Phase, 60 Cycles
150-Kv-a. Burke-Skinner Uniflow.
150-Kv-a. Westinghouse-Hamilton Uniflow.
125-Kv-a. Allis-Harrisburg.
50-Kv-a. Crocker-Wheeler-Ames.
150-Kw. General Electric Ames.
635-Kv-a. General Electric-Rice & Sargent.

Direct Current
50-Kw. Crocker-Wheeler-Ames.
50-Kw. General Electric, 3 wire, Erie Ball.
75-Kw. Crocker-Wheeler, 3 wire, Harrisburg.
75-Kw. Westinghouse-Erie-Ball.
125-Kw. General Electric, 3 wire, Erie Ball.
275-Kw. General Electric-Wetherill.

Large Stock Turbo Generators
Send for New Catalog
GEORGE SACHSENMAIER CO.
934 N. Third St. Philadelphia, Pa.

Steam Engine For Sale
1 Watts Campbell Corliss, Heavy Duty Steam Engine.
450 H. P.
Complete, practically new
Size: 24x42
Speed: 85 R. P. M.
Steam Pressure: 125 lb.
F. O. B. Passaic, N. J.
BOX 870
POWER PLANT ENGINEERING
53 W. Jackson Blvd., Chicago, Ill.

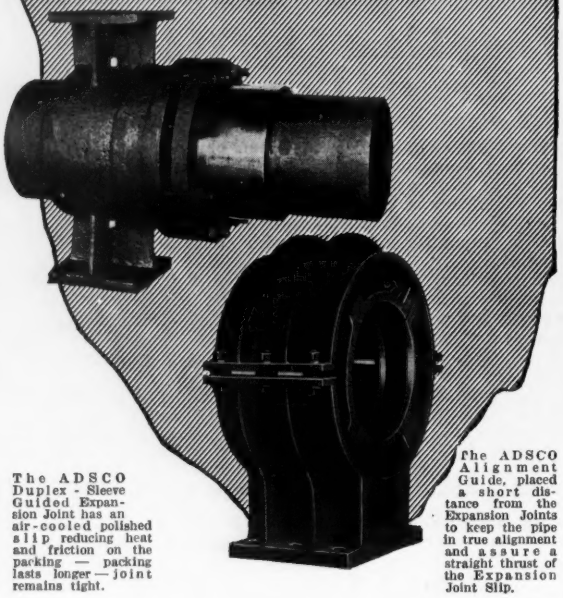
For Sale
Two 150 H.P. Return Tubular Boilers. Approved pressure 150 lbs.
Adolph Coors Company
Golden, Colorado

BOILERS ASME Code
627 H.P. Sterling, 160 lb. with superheaters, soot blowers and Taylor stokers $5500
414 H. P. Sterling, 160 lb. hand fired, with stack 3500
300 H.P. (2) Sterling, 160 lb. (no stoker) 4200
POWER PLANT EQUIPMENT CO.
39 Cortlandt St., New York City, N. Y.

FOR SALE
FOR SALE: 312 kv-a. Ft. Wayne, 2,400-v., 3-phase, 60-cycle generator, 250 r.p.m., direct connected to left-hand Buckeye double eccentric, bored guide type 20 by 21 engine belted exciter. Very low price if sold before moving.
Goodman Engineering Co.
9612 Thorn Ave., Cleveland, O.

Is it Air Compressors You Need?
12½x10 Am.-Fairhurst 355 ft.—100 lbs. Belted.
12½x12 Ing.-Rand Belted—50 Hp. 200-3-60 motor.
1000 ft. 2-stage Ing-Rand Dir-con 2200-V motor.
Garage Size. New Automatic tank outfit complete, $107
Many others—Also Centrifugal Pumps, Steam Pumps
ROY C. WISE, 1642 Monadnock Bldg., Chicago

ADSCO EXPANSION JOINTS



The ADSCO Duplex - Sleeve Guided Expansion Joint has an air-cooled polished slip reducing heat and friction on the packing — packing lasts longer — joint remains tight.

The ADSCO Alignment Guide, placed a short distance from the Expansion Joints to keep the pipe in true alignment and assure a straight thrust of the Expansion Joint Slip.

ADSCO EXPANSION JOINTS
Are Built for Every Possible Service Requirement; for any Pressure or Temperature. Many have been in use 40 years.

Use the coupon below for Bulletin 201. It is more than a catalog. It is a reference book, useful to any engineer who may ever specify Expansion Joints.

AMERICAN DISTRICT STEAM COMPANY
GENERAL OFFICES AND WORKS
NORTH TONAWANDA, N.Y.
Offices: New York, Chicago, Seattle

Pin This Coupon to Your Letterhead

P. P.

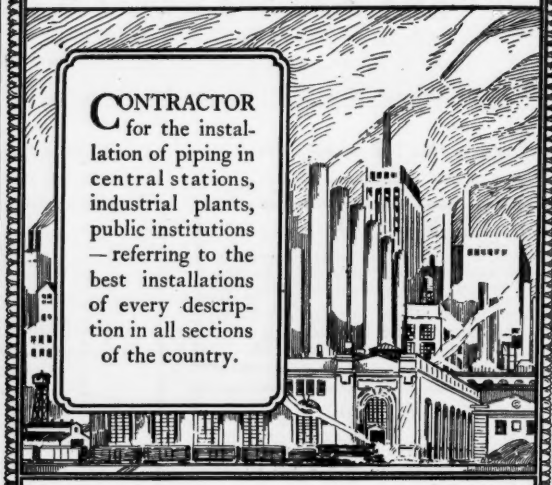
AMERICAN DISTRICT STEAM COMPANY North Tonawanda, N. Y.

Please send Bulletin 201 on Adsco Expansion Joints to

Name .....

Address .....

PIPING CONTRACTOR



CONTRACTOR for the installation of piping in central stations, industrial plants, public institutions — referring to the best installations of every description in all sections of the country.

WILLIAM A. POPE
Associates
WILLIAM H. MILLER R. A. WIDDICOMBE
S. AUSTIN POPE
26 North Jefferson Street, Chicago
Licensee: Sargol Joints (Patented)

The Babcock & Wilcox Tube Co.

Manufacturers of

SEAMLESS STEEL TUBES

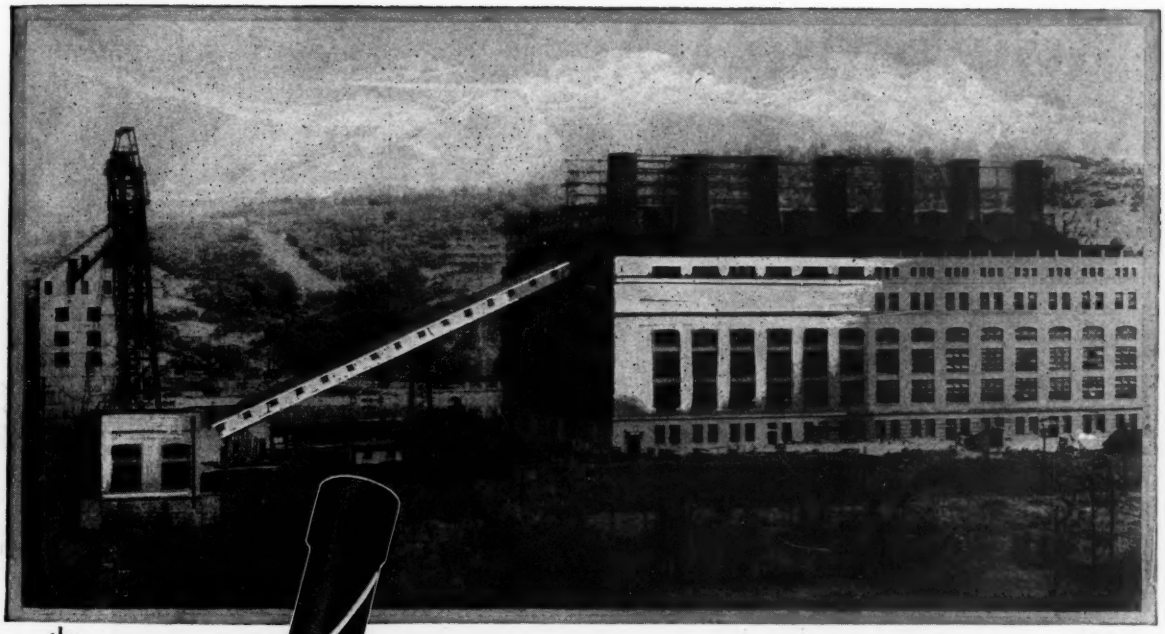
THE BABCOCK & WILCOX TUBE CO.

For Stationary, Locomotive and Marine Boilers

For over twenty years, the Company's mills have been making high grade tubes for Babcock & Wilcox boilers. The same careful selection of raw materials, close supervision of manufacture and rigid final inspection are followed whether the tubes are made for Babcock & Wilcox boilers or for any other purpose.

WORKS AND GENERAL OFFICES, BEAVER FALLS, PA.

New York, 85 Liberty St.
Pittsburgh, Farmers Deposit Bldg.
Boston, 49 Federal Street
Chicago, Marquette Bldg.
Philadelphia, Packard Bldg.
Cleveland, Guardian Bldg.



the *Spiral Stripe*
protects you against mistakes and substitution
Also look for name and year rolled in metal

Springdale Plant
Byers Pipe Installed for

Service Water Lines (Both Raw and Filtered)
Condensate Suction and Discharge
Deaerating Heater Overflow Lines
Boiler Feed (Both Suction and Discharge)
Blow-off Tank Drains
Safety Valve and Blow-off Vent Piping
Return Lines from Steam Traps
Air Lines from Condensers
Air Washers and Filter Lines
Drinking Water, Etc., Etc.

*Consulting Engineers
Sanderson & Porter
New York City

Arteries *of* Byers Pipe

for Better Health and Longer Life

THIS lusty young giant, the Springdale Plant of the West Penn Power Company, near Pittsburgh, after eight years' growth, boasts a capacity of 160,000 K. W.

In their efforts to make this plant one of the most efficient in the country, the engineers* did not overlook the importance of good pipe in securing low maintenance cost and absence of shut-downs.

Thus, Byers Pipe of genuine wrought iron was specified and installed for a wide variety of services where corrosion has to be reckoned with and where failures are likely to be expensive.

To choose materials with a proper regard for the service they are to perform is, of course, one of the fundamentals of good engineering. The selection of pipe materials involves an appreciation of differences in corrosive conditions existing in various lines. Thus, wrought iron, with its long record of durability, enters into the calculations of every good engineer, realizing that it fills, at a relatively low cost, the need for a material of dependable physical properties and high rust resistance.

In addition to these properties, Byers Pipe is noted for its good threading qualities; it is now also being successfully Van-Stoned, a fact which adds greatly to its range of usefulness.

Specify Byers Pipe and Byers Nipples

Ask for Bulletin No. 38
"The Installations Cost of Pipe"
Free on Request

A. M. BYERS COMPANY
Established 1864 **Pittsburgh, Pa.**
New York Philadelphia Boston Chicago
Los Angeles Cleveland Cincinnati
Rochester St. Louis Tulsa Houston
Jacksonville Birmingham
Distributors in all Jobbing Centers

BYERS PIPE

GENUINE WROUGHT IRON

9 Testing to prove Dependability of Seamless Boiler Tubes

THE processes to which the steel is subjected in the manufacture of "NATIONAL-SHELBY" Boiler Tubes are so severe that they amount in themselves to a dependable test of the material. In addition, all finished tubes are subjected to a hydrostatic pressure test as required by standard specifications and to various manipulating tests on sections cut from the actual tubes, including the flattening, flanging and crushing tests required by the A.S.M.E. Boiler Code and the A.S.T.M. Specification (for details of these tests see "NATIONAL" Bulletin No. 12, page 12); and, though not required by specifications, the pin test shown in the illustration is frequently made.

These tests, and the fact that the material is uniform and dependable enough to withstand the severe processes in manufacture, insure to the consumer tubes of exceptional uniformity — ductility — strength — and dependability in service.

Other steps in the manufacture of "NATIONAL-SHELBY" Seamless Boiler Tubes will appear here soon. For the complete story, write for a copy of "NATIONAL" Bulletin No. 12.

NATIONAL TUBE COMPANY, PITTSBURGH, PA.

DISTRICT SALES OFFICES IN THE LARGER CITIES

NATIONAL SEAMLESS BOILER TUBES

(SHELBY)

Thousands of Pounds of Pure Charcoal Iron Daily

IT requires the output of 20 furnaces to keep busy these enormous cooling tables in Reading's new tube mill.

Yet even this vast quantity of metal is no more than enough to keep abreast with the growing demand for Genuine Charcoal Iron Boiler Tubes made the "Reading" way.

If you have a definite idea of how long boiler tubes *ought* to last, change over to "Reading" and note how well they agree with your theory.

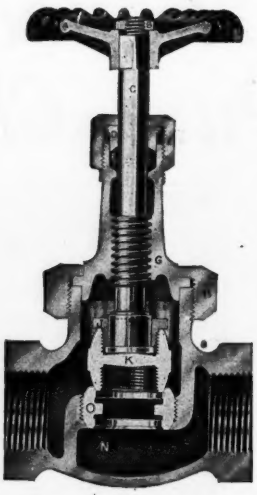
READING IRON COMPANY
READING, PA.

Also Manufacturers of Genuine Wrought Iron Pipe

Boston	New York	Los Angeles	Tulsa	Dallas
Pittsburgh	Detroit	Philadelphia	Baltimore	Buffalo
St. Louis	Cincinnati	Chicago	Seattle	Cleveland

READING
CHARCOAL IRON BOILER TUBES

Cuts valve costs in half



COSTS count in these days and the cost of a valve is by no means its first cost. Figured on the cost per year of leak-tight service, Reverso Valves win their way with the closest buyers.

Both seat and disc being easily reversible, the life of Reverso is doubled by this feature alone with no extra expense. Then each side of both the seat and disc are good for many regrindings.

Leading industries are specifying Reverso because of the unusual records they are making in economy. Engineers prefer them because of the time, trouble and repairs they save.

Order from your dealer and see for yourself. Write for bulletin No. 15.

REVERSO: Bronze Body for 200 lbs. Pressure. Total Temperature, 550° F.

IROVERSO: Iron Body for 150 lbs. Pressure. Total Temperature, 450° F.

REVERSO

The Valve with the Reversible Disc & Seat

The D. T. Williams Valve Co., Cincinnati, Ohio

Yes, *this* is the valve with the Anum-Metl Disc and Seat!

—the same metal that has saved so much money, time and trouble in the valves and seats of Strong Steam Traps — now is available in the disc and seat of this Strong Heavy Duty Valve, built right from top to bottom. Guaranteed for a year of leaktight service—but we can't describe it here—so write now for circular. It's a real valve.

The Strong, Carlisle & Hammond Co.

1392-94 West Third St.
Cleveland, Ohio

STRONG Heavy Duty Valve Leak-Tight for at Least One Year

FABRICATION ERECTION

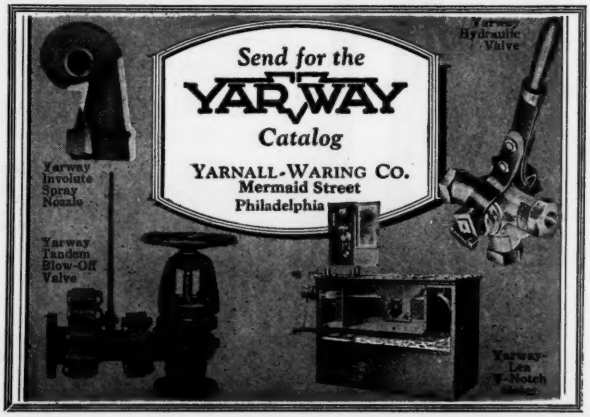
PIPE AND TUBING
FORGE OR GAS WELDED HEADERS

HIGHEST SUPERHEATED STEAM PRESSURES AND TEMPERATURES

NAVCO

ALL TYPES PIPE JOINTS COMPLETE POWER PIPING INSTALLATIONS

NATIONAL VALVE AND MANUFACTURING COMPANY
PITTSBURGH PENNSYLVANIA U.S.A.
ATLANTA CHICAGO CLEVELAND COLUMBUS NEW YORK PHILADELPHIA



On WATER COLUMNS use this small EVERLASTING Valve

For Boiler Blow-Off

Everlasting Valves are GUARANTEED DROP-TIGHT FOR TWO YEARS. They are self-cleaning, self-grinding, non-clogging and have no stuffing box, packing or repairs.

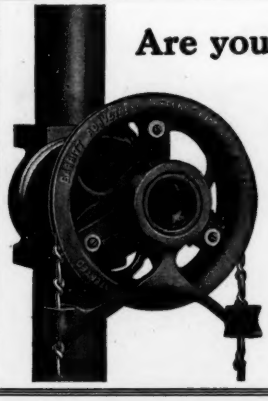
Because Everlasting Valves are so universally recommended as the valves that give trouble-free and drop-tight service on both high and low pressure boilers, you may have overlooked the many other places around the plant where they can effect economies in time and expense.

For example, the style shown above is making good on blow-downs for Water Columns, Soot Blower Drains, Throttle, Air, Gas and other service.

Write for full information and valve booklet.

Scully Steel & Iron Co.

P. O. Box 814, Chicago, Illinois



Are you waiting for someone to break his neck before you put Babbitt Rims on your overhead valves?

Don't Wait! It's Bound to Happen if You Do!

Don't Delay! Buy Now! Safety First

Babbitt Steam Specialty Co., Inc.
55 S. Water St.
New Bedford, Mass.

DESIGNERS AND BUILDERS

VALVES FITTINGS AND APPLIANCES

OF EVERY DESCRIPTION

For the installation of Steam, Gas, Water, Air and Hydraulic Piping

ATWOOD ATWOOD

PITTSBURGH VALVE, FOUNDRY & CONSTRUCTION CO.

PITTSBURGH PA.

Safety, Dependability and Economy

Essential factors to be considered in every Power Plant.

POWELL VALVES

insure entire satisfaction.

Fig. 375

White Star Gate Valve. Sizes ¼ to 3 inch.

White Star Valves adapted to most any service demands are especially designed for unusual conditions.

All White Star Valves are furnished with Powellium nickel discs. Both globe and gate valves are obtainable with renewable seats.

Seats and discs, the two essential wearing parts of these valves, are constructed for long life and ease in regrinding when necessary. The renewable features offer considerable economy for length of service obtained.

Specify POWELL WHITE STAR VALVES on your next requirement and be convinced. Circulars on request.

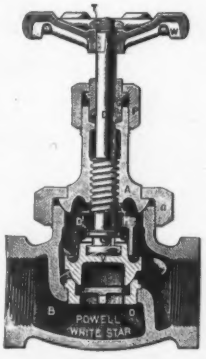


Fig. 102

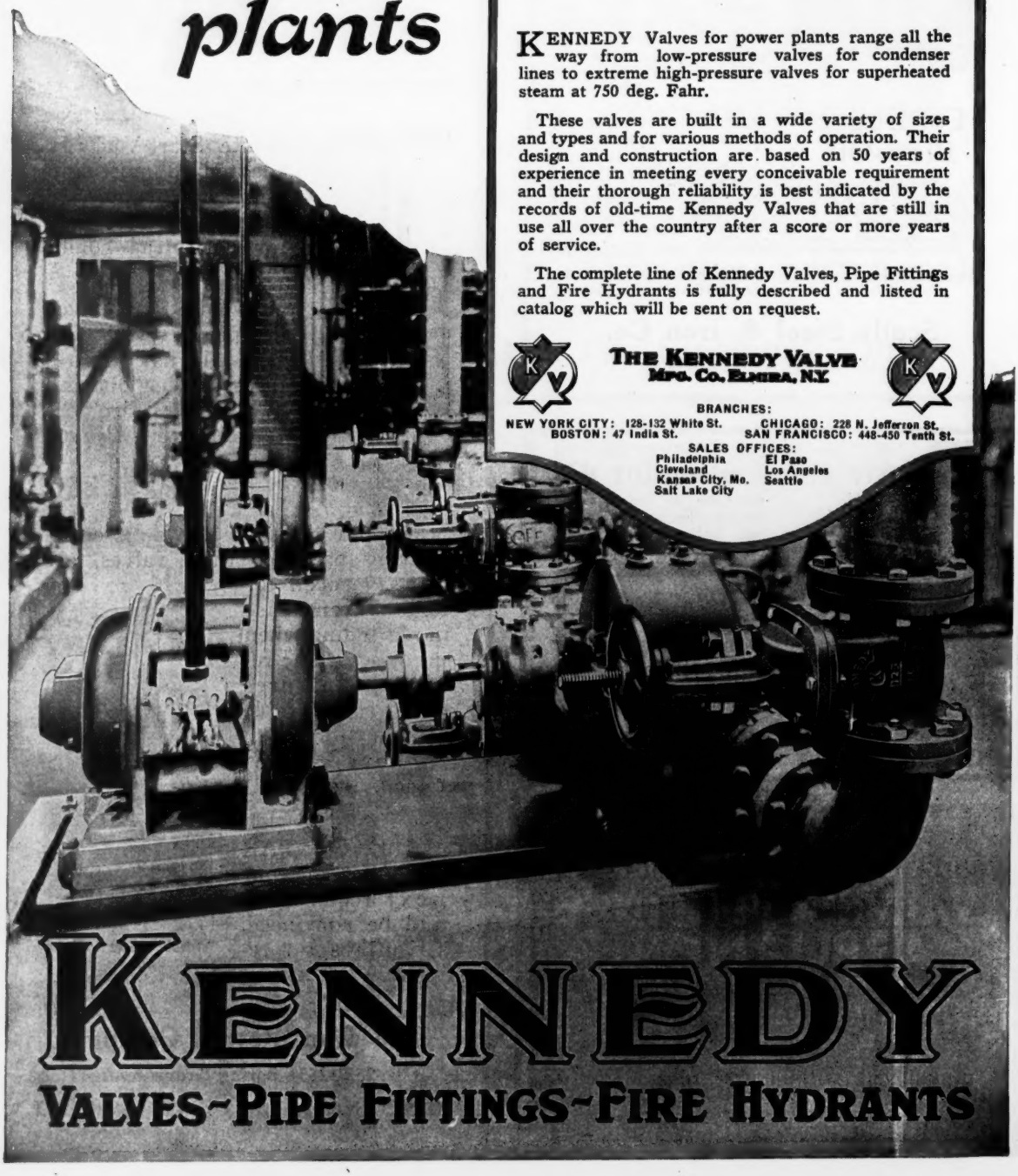
White Star Globe Valve. Sizes ¼ to 3 inch.

The Wm. Powell Company

2521-2531 Spring Grove Ave.

CINCINNATI OHIO

Valves *for power plants*



KENNEDY Valves for power plants range all the way from low-pressure valves for condenser lines to extreme high-pressure valves for superheated steam at 750 deg. Fahr.

These valves are built in a wide variety of sizes and types and for various methods of operation. Their design and construction are based on 50 years of experience in meeting every conceivable requirement and their thorough reliability is best indicated by the records of old-time Kennedy Valves that are still in use all over the country after a score or more years of service.

The complete line of Kennedy Valves, Pipe Fittings and Fire Hydrants is fully described and listed in catalog which will be sent on request.

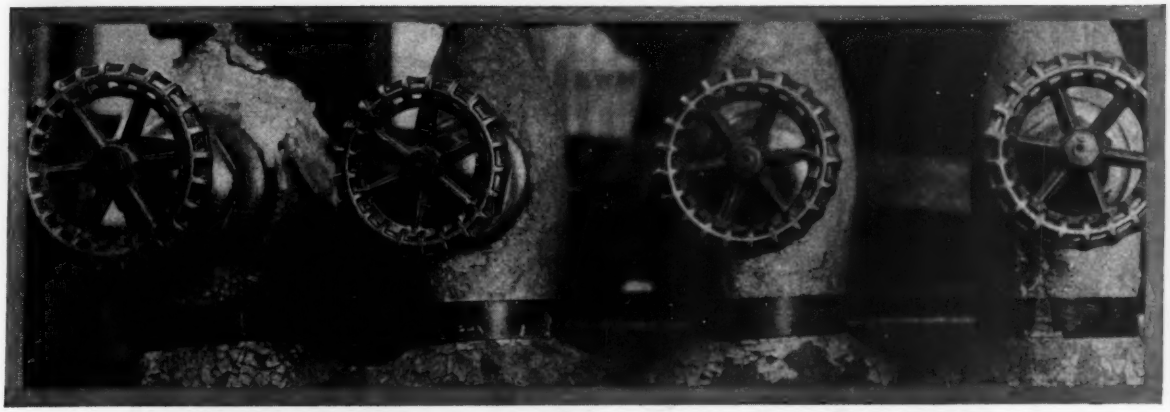
THE KENNEDY VALVE MFG. CO., ELMIRA, N.Y.

BRANCHES:
NEW YORK CITY: 128-132 White St. CHICAGO: 228 N. Jefferson St.
BOSTON: 47 India St. SAN FRANCISCO: 448-450 Tenth St.

SALES OFFICES:
Philadelphia El Paso
Cleveland Los Angeles
Kansas City, Mo. Seattle
Salt Lake City

KENNEDY

VALVES-PIPE FITTINGS-FIRE HYDRANTS



Automobile Wheels and Valves

Yes, there is a connection. It is no small part that Jenkins Valves play in the daily production of thousands of automobile wheels.

In the plant of the Kelsey Wheel Co., Detroit, are many Jenkins Valves — in service because Mr. George Seiger, Power Plant Engineer, can rely on them to aid in keeping his plant at its highest efficiency.

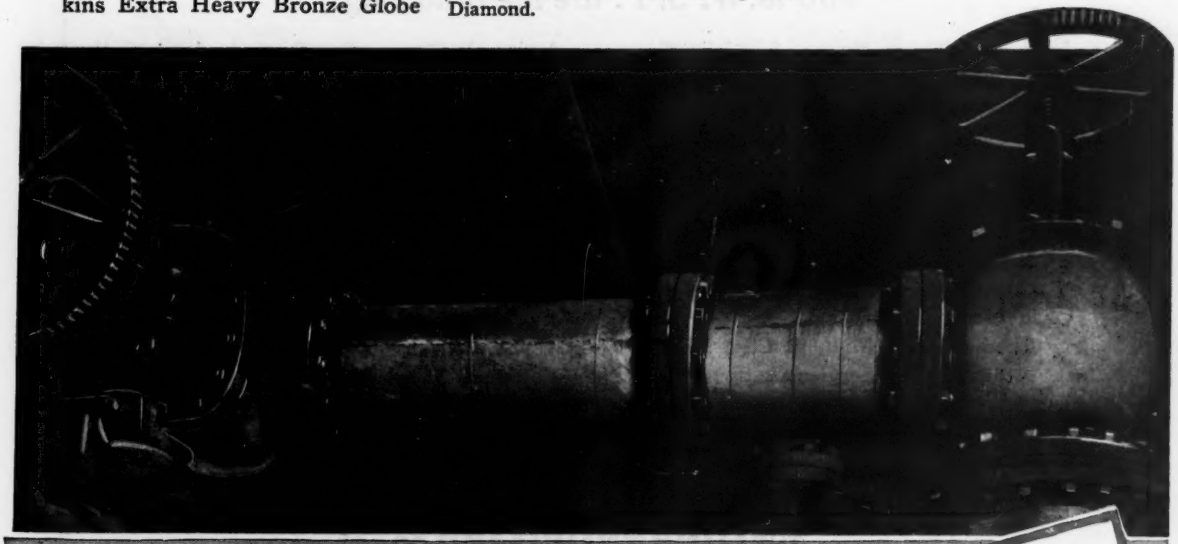
The valves shown above are on the soot blowers. They are Jenkins Extra Heavy Bronze Globe Valves suitable for 300 pounds working steam pressure.

Below are illustrated a Jenkins Automatic Equalizing Stop and Check Valve and Jenkins Extra Heavy Iron Gate Valve on line to header.

There are Jenkins Valves for practically every valve requirement. Furnished in bronze and iron, in standard, medium pressure, and extra heavy patterns. At supply houses everywhere. Assure long time valve service by insisting on genuine Jenkins Valves—always marked with the Jenkins Diamond.

Fig. 293

Flanged Jenkins Extra Heavy Iron Body Automatic Equalizing Stop and Check (Non-return) Angle Valve.



Always marked with the "Diamond"

Jenkins Valves

SINCE 1864

JENKINS BROS.

80 White Street.....New York, N. Y.
524 Atlantic Avenue.....Boston, Mass.
133 N. Seventh Street.....Philadelphia, Pa.
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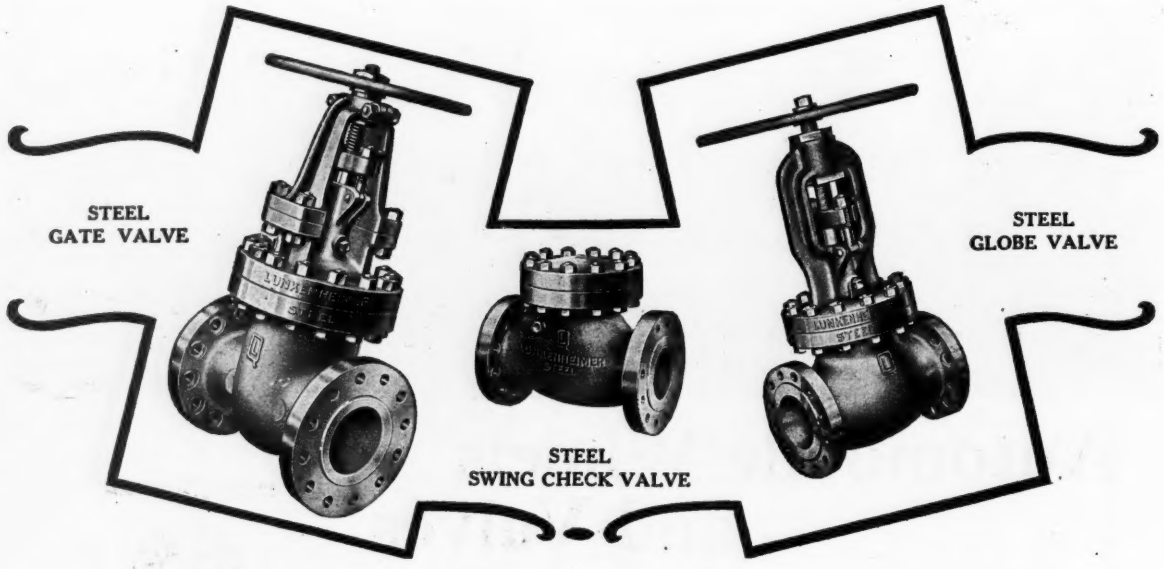
JENKINS BROS., Limited

Montreal, Canada London, England



LUNKENHEIMER STEEL VALVES

PROCURABLE FOR

250, 400, 600 AND 900 LB. W. S. P.

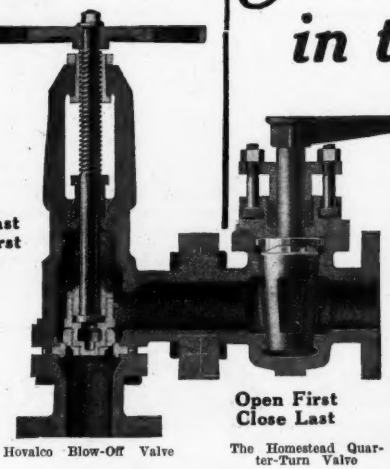
Among the Central Power Stations and Industrial Plants which are large users of Lunkenheimer Steel Valves for 400, 600 and 900 lb. W. S. P. are the following:

Columbus Railway, Power & Light Co., Columbus, Ohio.
Illinois Electric Power Co., Peoria, Ill.
United Light & Power Co., Davenport, Ia.
Nebraska Power Co., Omaha, Nebr.
Columbia Power Co., Columbia, Ohio.
Philadelphia Electric Co., Philadelphia, Pa.
Long Island Lighting Co., Northport, N. Y.
Narragansett Electric Light Co., Providence, R. I.
Dow Chemical Co., Midland City, Mich.
San Antonio Public Service Co., New Braunfels, Texas.
Portland Electric Co., Portland, Ore.
Anaconda Copper Co., Perth Amboy, N. J.
Connecticut Light & Power Co., Devon, Conn.
Detroit Edison Co., Trenton Channel, Mich.
Detroit Edison Co., Marysville, Mich.
Reynolds Tobacco Co., Richmond, Va.
Peoples Gas & Electric Co., Mason City, Iowa.
Detroit Public Lighting Commission, Detroit, Mich.
General Engineering & Management Corp., St. Petersburg, Fla.
Potomac Electric Power Co., Bennings, D. C.
Solvay Process Co., Syracuse, N. Y.

THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI, OHIO, U. S. A.
NEW YORK CHICAGO BOSTON LONDON
EXPORT DEPT. 129-135 LAFAYETTE ST., NEW YORK

15-35-44

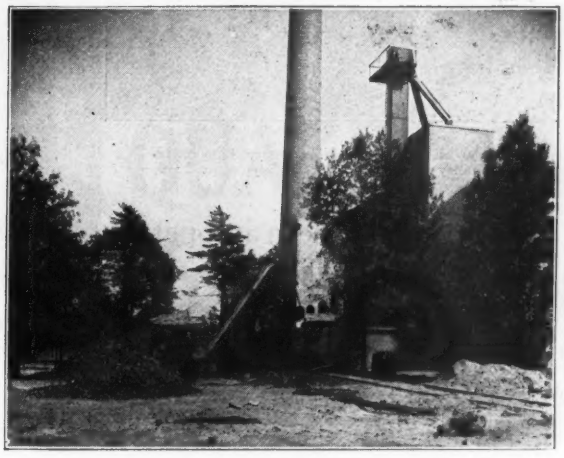
VALVES of LASTING SERVICE in this economical Shop Power Plant



The Hovalco Blow-Off Valve

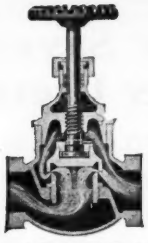
Open First
Close Last

The Homestead Quarter-Turn Valve



At right, New Sullivan Machinery Co. plant, erected for the manufacture of compressed air tools and machinery that make possible our subways, tunnels, skyscrapers and many modern industries.

*See article entitled "Shop Power Plant Shows Economical Operation," in March 15, 1926, issue of Power Plant Engineering.



Homestead Protected Seat gives from two to three times the service of ordinary valves on steam, air and hydraulic services.

Three-Way Quarter-Turn Valve

Straight-Way

Homestead 4-Way Quarter-Turn Valve. Also in 3-Way and Straight-Way, both regular and lubricated. Metals and types for all services, screwed or flanged.

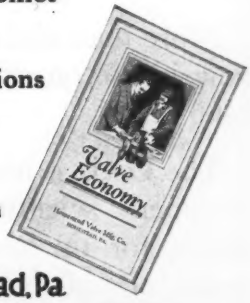
HOVALCO-HOMESTEAD **Blow - Off Valves** were selected for all the boilers in the new Sullivan Machinery Co. plant at Michigan City, Ind., because they are economical and reliable.*

In the Combination Blow-Off, next to the boiler, stands one of the Straight - Way Homestead Quarter-Turn Valves, developed for leak-tight, free-acting, enduring service.

The Hovalco, Homestead's contribution to safety, economy and durability on blow-off, is in front of the Quarter - Turn Valve. Hovalco regulates the blow-off. Built especially for this service with monel metal seats and discs that are regrindable, reversible and renewable. This is why a similar installation in the Singer Building, New York City, has given 14 years' continuous blow-off service.

For more economical plant operation know the many advantages of the Homestead line of "Valves of Lasting Service" backed by 34 years' experience. Consult us freely. Write for this

24-page booklet containing 30 illustrations and handy reference information



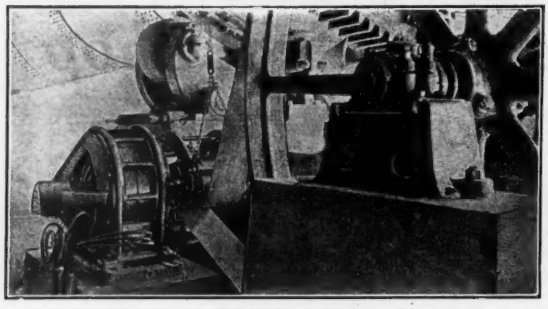
Homestead Valve Manufacturing Company, Homestead, Pa

HOMESTEAD

PRODUCTS:—Quarter Turn Valves—Straight-Way Three-Way Four-Way Types—Full Round-Way Valves—Cast Steel Refinery Valves—Lubricated Valves—Hovalco Blow-Off Valves—Protected Seat Globe Valves B&O Pat.—Protected-Seat Hydraulic Operating Valves

THE LENIX DRIVE

(Trademark Reg.)



Lenix with 50 H.P. motor driving rotary kiln in cement plant. Pulley centers 8' 0"; Pulley ratio 1:10.

This "old-timer" has been in operation sixteen years. It is installed in connection with a 50 h.p. motor driving a rotary kiln in a portland cement plant. The kiln operates night and day, practically every day in the year.

This excellent record of performance is proof of the engineering, workmanship and materials entering into the construction of the Lenix.

Wherever belts are used for the transmission of power the Lenix will improve the operating conditions of the drives. The Lenix automatically adjusts the tension in the belt in response to changes in the load. The short pulley centers save floor space.

More than eight thousand Lenixes are now in use on drives ranging from 1 to 1400 h.p.

The Lenix is not an idler. It is a "belt wrapper" scientifically applied to belt drives for the purpose of saving floor space, eliminating belt slippage and increasing the general capacity of the drive.

A card will bring you full information.

F. L. SMIDTH & CO., Inc.
Engineers
50 Church St. New York, N. Y.

BELT DRESSING FOR ALL BELTS

FREE ½ lb. Sample Bar

STEPHENSON BAR BELT DRESSING

FOR SLIPPING BELTS PREVENTS SLIPPING

Write your name, firm name, and address, on the margin of this page, tell us the kind of belt or rope drive to be treated, tear out, mail, and we will send FREE a half-pound sample bar of STEPHENSON.

We also have a 30-lb. 30-day trial offer. Want to learn about it?

STEPHENSON MFG. CO.
15 Spring, Albany, N. Y.

Trade Mark Registered

MORSE SILENT CHAIN DRIVES

THE MORSE "ROCKER JOINT"

A Power Saver for Power Users

MORSE CHAIN CO., Ithaca, N. Y.

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WE ARE fully equipped to supply fabricated materials and to install complete piping systems for Electric Power Stations, Blast Furnaces, Steel Mills, Coke Works and Industrial Plants of every description—backed by an experience of almost a quarter century.

PITTSBURGH PIPING & EQUIPMENT CO.

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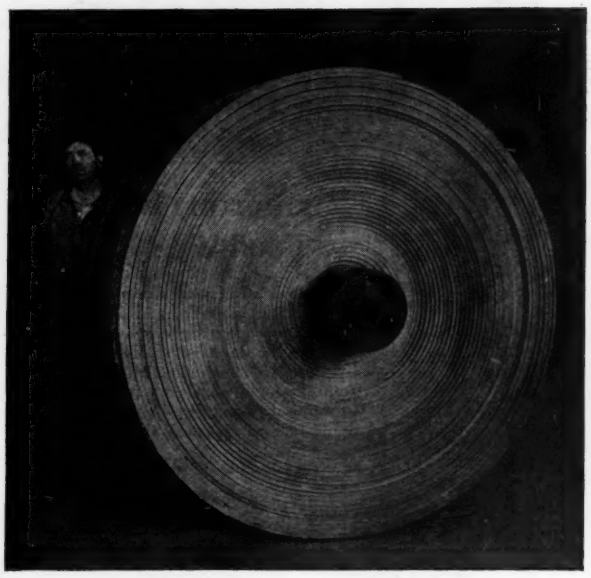
New York 220 Broadway — Chicago Peoples Gas Bldg. — San Francisco Call Bldg. — Cleveland Ulmer Bldg.
Houghton, Mich. Traction Terminal Bldg. — Detroit Dee Bldg. — Indianapolis — General Motors Bldg.



Extreme heat, Moisture, Grit— QUAKER Belts for Endurance

Whatever the need for transmission belts, QUAKER rubber belting can be used. And there are cases where operating conditions are exceptionally severe, wet, dry or hot, or where belting is exposed to the weather, when rubber belts are unquestionably the most suitable and efficient.

There is good, solid foundation for this statement, based on forty years of manufacturing experience and thousands of belting installations in factories and shops. QUAKER belts are uniform in thickness, grip tight, and do not shrink, and the materials used in their construction give strength and great resistance to wear and tear.

QUAKER belts are manufactured from finest cotton duck, the plies thoroughly frictioned, and are made in sizes and grades to cover the entire range of industrial needs.

There is a belt for every drive, and we make the belt.

QUAKER CITY RUBBER COMPANY

Established 1885

Manufacturers of Rubber Goods, Tires and Tubes

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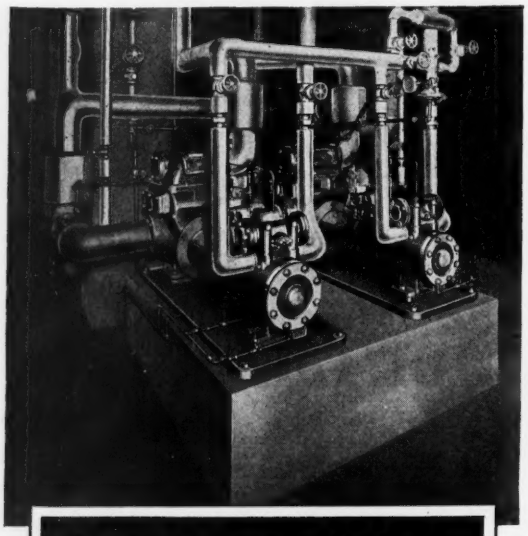
WORTHINGTON

Worthington Simplex Pumps
in Boston City Hall Annex



Preferred by many - because of its simplicity

THE simplex steam pump has the advantage of being exceptionally simple in construction, of great reliability and is free of any tendency to short stroke.

Once started it will keep on pumping with the same regular, rhythmic movement until the steam is shut off.

These are the reasons that this type of pump is preferred by many busy engineers for such services as boiler-feed, plant water supply, vacuum heating and general water service.

Pumps Condensers Compressors
Oil and Gas Engines Oil and Water Meters
Feedwater Heaters

WORTHINGTON PUMP AND MACHINERY CORPORATION
115 BROADWAY, NEW YORK, N. Y.

Please send me bulletins on Simplex and Duplex steam pumps.

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Company_____

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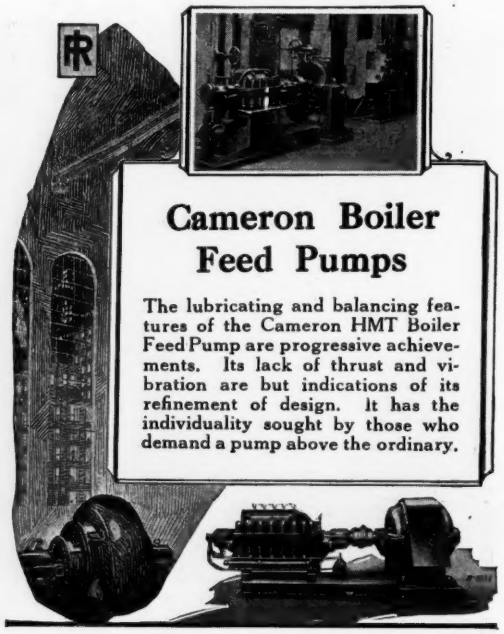

Cameron Boiler Feed Pumps

The lubricating and balancing features of the Cameron HMT Boiler Feed Pump are progressive achievements. Its lack of thrust and vibration are but indications of its refinement of design. It has the individuality sought by those who demand a pump above the ordinary.

231-DV

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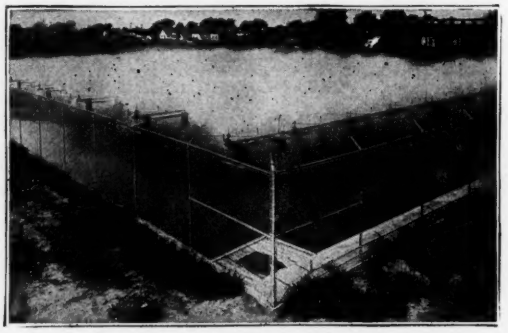
Offices in principal cities the world over
For Canada, Refer Canadian Ingersoll-Rand Co., Limited, 260 St. James Street, Montreal, Quebec

Ingersoll-Rand

A. S. Cameron Steam Pump Works



COOLING POND EQUIPMENT

Designed by Specialized Engineers

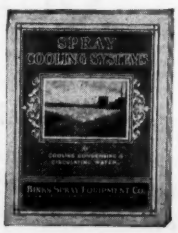
The variation in steam condenser circulating water cooling systems makes the recommendations of specialized engineers advisable. Every plant, regardless of size, has its own peculiar problems—problems that are not new to Binks engineers. In over 2500 plants, Binks engineers have left their indelible record of efficient, economical operation.

Before you plan or specify Cooling Pond equipment, let Binks engineers discuss the subject with you. Their recommendations may save you initial investment as well as future operating costs. An invitation to call implies no obligation.

Write for this Book.

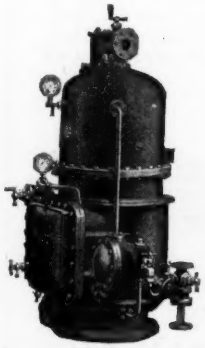
A Book for Power Plant Executives

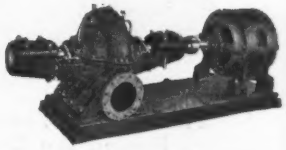
Every operator with a water cooling problem should find many valuable suggestions in this book. A copy will be mailed upon request. Ask for our book "Spray Cooling Systems." Write today.



BINKS SPRAY EQUIPMENT COMPANY
Dept. M, 3130 Carroll Ave., Chicago
Offices in Principal Cities

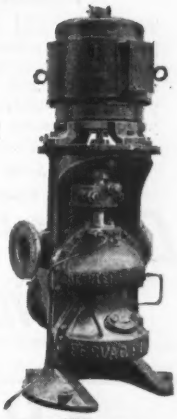
Some typical units *of* Bethlehem Power Plant Equipment

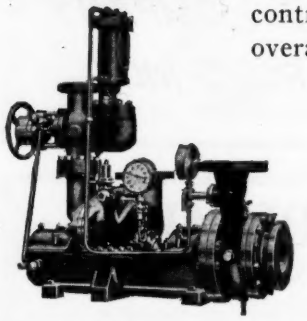




THE varied assortment of Power Plant Equipment manufactured by Bethlehem Steel Company is such that it includes units for auxiliary service throughout the whole heat cycle.

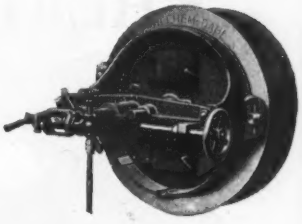
The illustrations herewith show only a few typical units representative of the complete line which we make. Whichever unit is chosen and whatever its application, it has the capability that enables it to contribute substantially and permanently to the overall economy of the plant.



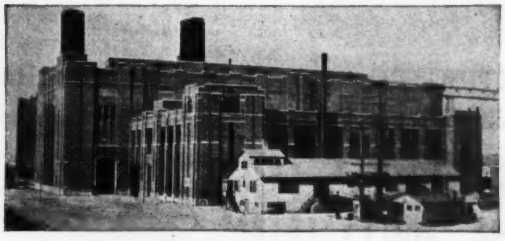


Bethlehem Power Plant Equipment Includes:

- Bethlehem (Dahl) Mechanical Fuel Oil Burning System
- Bethlehem Pulverizers
- Diesel Oil Engines
- Motor- and Turbine-driven single-stage centrifugal Boiler Feed Pumps and General Service Pumps
- Motor-driven reciprocating General Service Pumps
- Steam-engine-driven single-stage centrifugal Circulating Pumps
- Motor-driven single-stage centrifugal Oil Pumps
- Submerged-tube Evaporators
- Steam-driven reciprocating Fuel Oil, Lubricating Oil and Boiler Feed Pumps
- Motor- and Turbine-driven single-stage centrifugal Extraction or Condensate Pumps
- Surface Feed Water Heaters



Typical Plants and Buildings in which Bethlehem Power Plant Equipment is Installed



BETHLEHEM STEEL COMPANY, *General Offices:* BETHLEHEM, PA.

District Offices

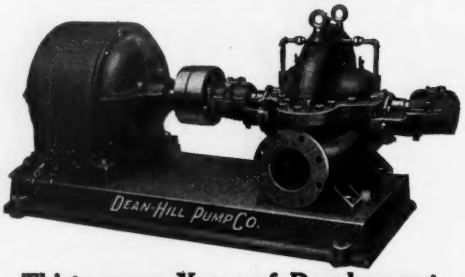
New York Boston Philadelphia Baltimore Washington Atlanta Pittsburgh Buffalo Cleveland Cincinnati Detroit Chicago St. Louis San Francisco Los Angeles Seattle Portland

Bethlehem Steel Export Corporation, 25 Broadway, New York City, Sole Exporter of Our Commercial Products

BETHLEHEM

DEAN HILL

Centrifugal Pumps and Steam Turbines



Thirty-seven Years of Development Behind the Dean Hill Pump

The Dean Hill Pump Co. has been manufacturing pumps continuously since 1889. Nothing has been spared in the development of its product. The highest engineering and designing skill—the best materials procurable—unexcelled manufacturing facilities; are your assurances of equipment representing the highest development in the pump and turbine industry.

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New York Office: 149 Broadway

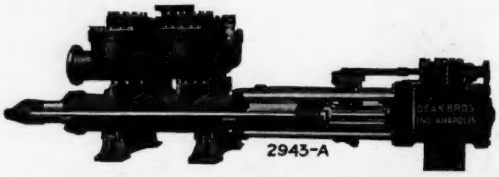
DEAN HILL PUMP CO.

ANDERSON IND.

DEAN BROS.

AN INDIVIDUAL PUMP

"Individual" in Design, in Construction, in Operation —combining large capacity with small expenditure of Steam. The Dean Durable Duplex Steam Pump is long stroke, smooth running. Design and construction of valve movement overcomes tendency to short stroke; therefore pump operates at full capacity at all times.



NEW YORK SALES OFFICE: 149 BROADWAY

ESTABLISHED 1869

DEAN BROS. COMPANY

INDIANAPOLIS IND.

323 W. 10th STREET

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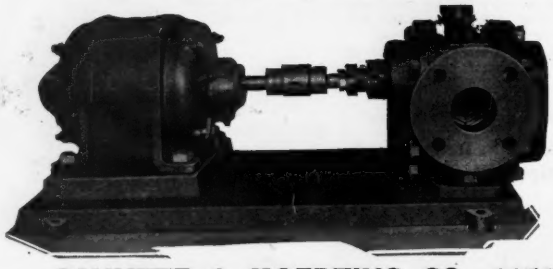

Direct connected—high speed—ball bearings

Standard or reversible types—with or without bypass

Recommended for starting and standby oil pump sets

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Also spur gear pumps for low speeds—Bulletin 17-A

SCHUTTE & KOERTING CO., 1156 Thompson St., PHILADELPHIA, PA.

1876—In business 50 years—1926

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WARREN PUMPS

High grade centrifugal and reciprocating pumps for every power plant service. Designed, built and tested for years of dependable service at least cost for operation and maintenance

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Single and multistage centrifugal pumps; steam and power reciprocating pumps of all accepted designs.

MOTORS

For general and special purposes in sizes from ¼ to 600 horsepower.

DIESEL ENGINES

From 40 horsepower up to units for serving large power demands.

See our ad in the last issue.
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28 Branches throughout the United States at your service

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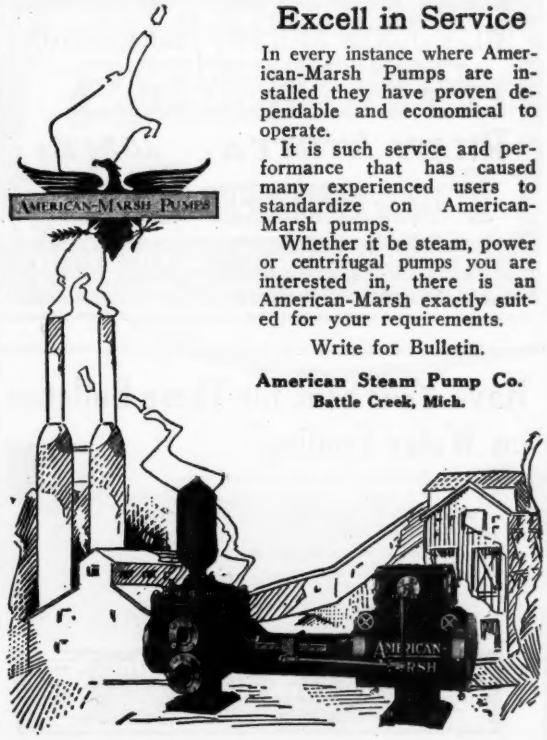
American-Marsh Pumps



Excell in Service

In every instance where American-Marsh Pumps are installed they have proven dependable and economical to operate.

It is such service and performance that has caused many experienced users to standardize on American-Marsh pumps.

Whether it be steam, power or centrifugal pumps you are interested in, there is an American-Marsh exactly suited for your requirements.

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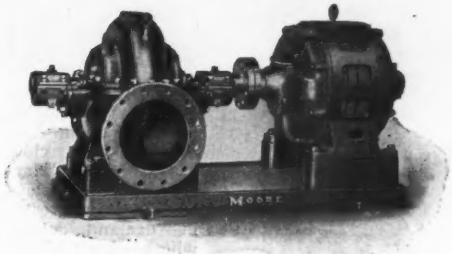
American Steam Pump Co.
Battle Creek, Mich.

MOORE

Centrifugal Pumps are GOOD



GROWTH

The rapid growth in the use of Moore Pumps is due to—

Low operating costs
Low maintenance
Competitive initial cost
Splendid workmanship

Let us quote upon a definite requirement. You will be well repaid.

CENTRIFUGAL PUMPS
STEAM TURBINES, REDUCTION GEARS

MOORE STEAM TURBINE CORPORATION
Wellsville, N. Y.

DEPENDABLE PUMPING EQUIPMENT

is insured by specifying Yeomans Equipment. Used the world over in leading Central Stations, Power Plants, Hotels, etc.

Established 1898

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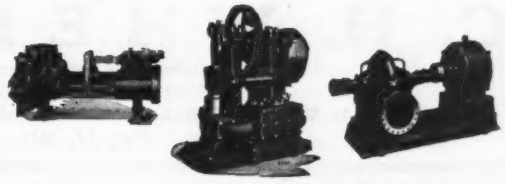
1432 Dayton Street, Chicago, Illinois

Pumping Equipment for Every Service — Automatic Bilge Pumps, Sewage Ejectors and Centrifugal Pumps.

Canadian Representatives: Darling Brothers, Ltd., Montreal. Representatives in all principal cities.

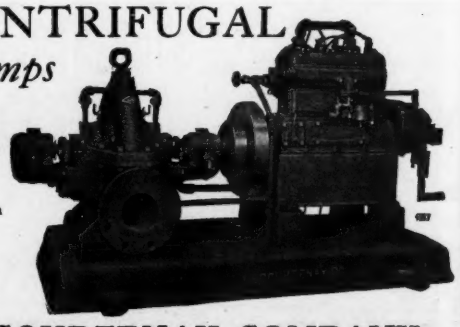


Platt Iron Works

Dayton, Ohio

"Platt" and "Smith-Vaile" Pumps
Steam and Power Pumping Machinery

CENTRIFUGAL *Pumps*



Capacities
25 g.p.m.
to
25,000 g.p.m
Heads
to over
1200 ft.

LECOURTENAY COMPANY
7 Maine Street, Newark, N. J.

TABER-PUMPS

CENTRIFUGAL & ROTARY

Fig. 192 Taber Open Impeller type Centrifugal Pump

Quality, design, materials, and workmanship enter into every Taber pump. We build to suit your specific needs.

Submit your pumping problem to us.

TABER PUMP CO.
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MARLEY SPRAY NOZZLES

COMPLETELY satisfying the need for a spray nozzle that delivers a fine uniform spray at low operating pressure and one that will not clog, has made the "Marley" Spray Nozzle a leader. It is greatly in demand everywhere—and is today one of the fastest selling spray nozzles on the market. Bulletins tell the story. Write for your copy today.

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A Type for Every Combustion Need
RILEY-JONES-MURPHY-HARRINGTON
STOKERS
RILEY ATRITA UNIT SYSTEM
PULVERIZED COAL
RILEY STOKER CORPORATION
9 Neponset St., Worcester, Mass., U. S. A.

Have *You* Sent for These Bulletins on Water Cooling?

These two bulletins, one on cooling towers and the other on spray ponds, cover the information you should have on water cooling equipment. Tear out this advertisement now, attach to your letterhead and mail. Bulletins will go forward at once.

15 John St., New York
Representatives in principal cities
The Cooling Tower Co., Inc.
NEW YORK

C. H. WHEELER CONDENSING EQUIPMENT

Surface Condensers, Low Level Jet Condensers, Barometric Condensers, with all auxiliaries, including the Radojet Ejector Air Pump
C. H. WHEELER MFG. COMPANY, 19th St., Lehigh and Sedgley Aves., PHILADELPHIA, PA.
"C. H. Wheeler of Philadelphia"

NEW YORK BELTING & PACKING CO.

New York Boston Chicago Philadelphia Pittsburgh St. Louis San Francisco
Manufacturers High Grade Rubber Goods for Mechanical Purposes
"Indestructible" White Sheet Packing
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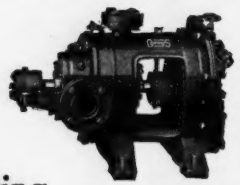
TURBO BOILER FEED PUMPS

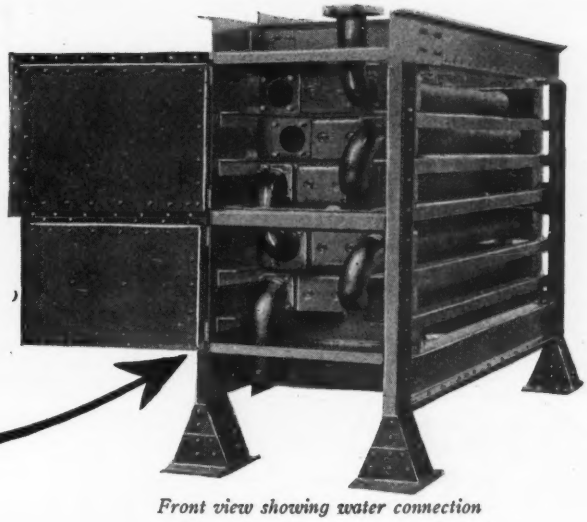


Perfect Boiler Feeding *Steam Turbine Driven*
Coppus Engineering Corporation
340 Park Ave., Worcester, Mass.

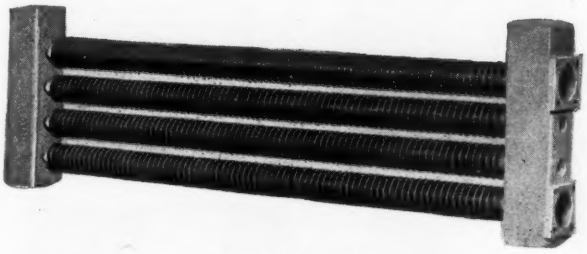
MANISTEE "RoTURBo"

CENTRIFUGAL PUMPS
ROTARY JET CONDENSERS
Manistee Iron Works Co., Manistee, Mich.

The Economizer Unaffected by Corrosion

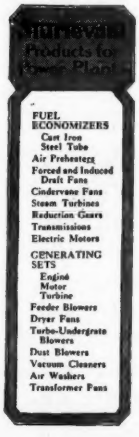


Front view showing water connection



Type "V" Section

Lead coated steel tubes of unique design abolish the corrosive action of oxygen and acid



Simplicity of design, tightness of casings, maximum heat transfer, minimum air infiltration and protection against corrosion, are points to watch for in selecting your economizer.

To provide an economizer for the power plant industry that will not be affected on the outside by acid in the flue gases or the inside by oxygen in the water, Sturtevant engineers have developed a lead-coated steel tube economizer with extended surface. The pipes with the discs assembled are lead coated and then expanded into headers of forged or cast steel. The steel discs are put on the pipe so tightly by our patented process that an indentation appears on the pipe under every disc. By this method the transfer of heat from gas to water is amazingly efficient.

This economizer has been so successful that power plant engineers will find this lead-coated steel tube extended surface economizer the satisfactory means of abolishing the corrosive action of oxygen and acid in economizer tubes.

Our engineers will gladly give you any desired information. Bulletin No. 334 will be sent on request.

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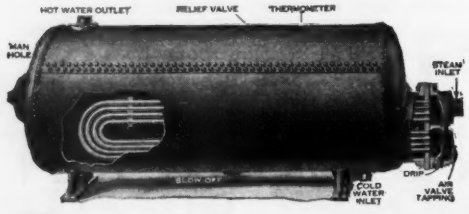
The same skill and shrewdness that have made the Borden Company leaders in their line, enabled them to see the big advantages of selecting Patterson Hot Water Service Heaters to furnish 423,375 gallons of hot water per month to supply 2,000 people in this gigantic building.

All "chance" is eliminated when Patterson Hot Water Heaters are installed. They *must* make good because a 45-year-old concern guarantees that they will deliver all the hot water required, as fast as needed and as quickly as it can be drawn.

The owners of thousands of buildings in every section of the country testify to the efficiency and durability of the Patterson. Please write for catalog and list of users in your section.

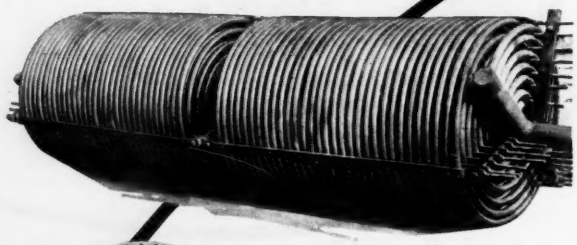
The Patterson-Kelley Co.
Architects Building, New York City

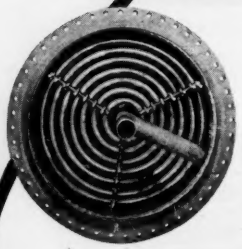


Patterson
Hot Water Heaters

NATIONAL

Heat Transfer Apparatus





Perfectly made coils are the heart of this special unit. National coils have exclusive features which give more efficient operation.

End view of coils in shell emphasizes concentricity and good workmanship.

Below is the complete, manufactured unit, seams tightly riveted and ready for years of service.

National will design and fabricate any type of apparatus that you require

Successful installations of large and complicated types of heat transfer apparatus have been credited to National during the past 43 years. Equipped with an efficient engineering staff, modern plant and skilled labor, we are ready to tackle your problem, to design and fabricate high grade apparatus that will equal or exceed specifications. Let us quote on your installation. Our field engineers will call at your request.

As we are one of the largest and oldest producers of Feed Water Heaters, Oil Heaters or Coolers, Air Coolers or Evaporators — our experience is at your service. Write for Bulletin.

The National Pipe Bending Company
Established 1883 **160 River Street**
NEW HAVEN, CONNECTICUT
Boston **New York** **Philadelphia**

A Suggestion on Coal Saving

"We Keep Others in Hot Water"

Forty years' experience insures the most practical and efficient design in this heater.

B. H. Type Heaters give an unfailing supply of hot water. All capacities are guaranteed.

AS a factor in fuel saving, efficiency of heat transfer in water heaters is as important as in the boiler itself.

We have studied the problem of feed water and service water heating in this light. The result is shown in hundreds of plants, hotels, apartments, business blocks, laundries, factories, etc., where our equipment is supplying hot water at low cost and high efficiency.

SIMS

Storage Water Heaters

The SIMS Company
2001 Holland St., Erie, Pa.
A good place in which to live, to work and to play.

Sims Type B. H. Storage Water Heater shown above is unsurpassed for supplying large quantities of hot water with either live or exhaust steam.

Highly efficient, dependable in operation, and construction that insures the utmost durability, makes it the standard heater with architects, owners and engineers. Write for bulletin with valuable tables and other data.

GRISCOM-RUSSELL

Evaporators—Feed Water Heaters—Generator Air Coolers—Lubricating Oil Coolers—Steam, Air and Oil Separators—Filters—Strainers—Expansion Joints

Described in bulletins which will be sent on request

THE GRISCOM-RUSSELL COMPANY, Dept. C, 285 Madison Avenue, NEW YORK

ECONOMIZERS
Foster Preheating and Superheating Surfaces for boiler and industrial processes steady the heating action, prevent overheating, and save fuel by increasing the heating efficiency.

AIR HEATERS

FOSTER

SUPERHEATERS
The value of Foster Heat Engineering Service and Foster Construction are proven by more than 20 years of experience and over 11,000 installations in every industry and in every type of plant.

WATER WALLS

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The Mark of Quality

HOPPES

Specialties:
Exhaust Steam
Feed Water Heaters
Live Steam Purifiers
V-Notch Meters
Combination Heaters and Meters
Steam Separators, all types
Oil Eliminators
Exhaust Heads

EVERY Hoppes product is backed by 40 years spent in perfecting of better Steam Specialties. There are Hoppes Feed Water Heaters and Purifiers that meet every requirement. They heat, purify and soften the feed water without the use of chemicals or expensive filtering apparatus. Write for catalogue.

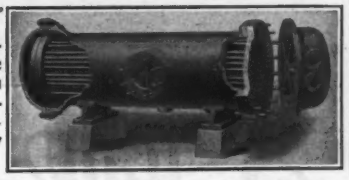
The Hoppes Manufacturing Co.
70 Larch St., Springfield, Ohio

ROSS

BLEEDER AND INSTANTANEOUS HEATERS—HEAT EXCHANGERS

"Better than Specified"

Leader of the heaters, this Ross type has proved its worth wherever used, including central stations and utility companies.



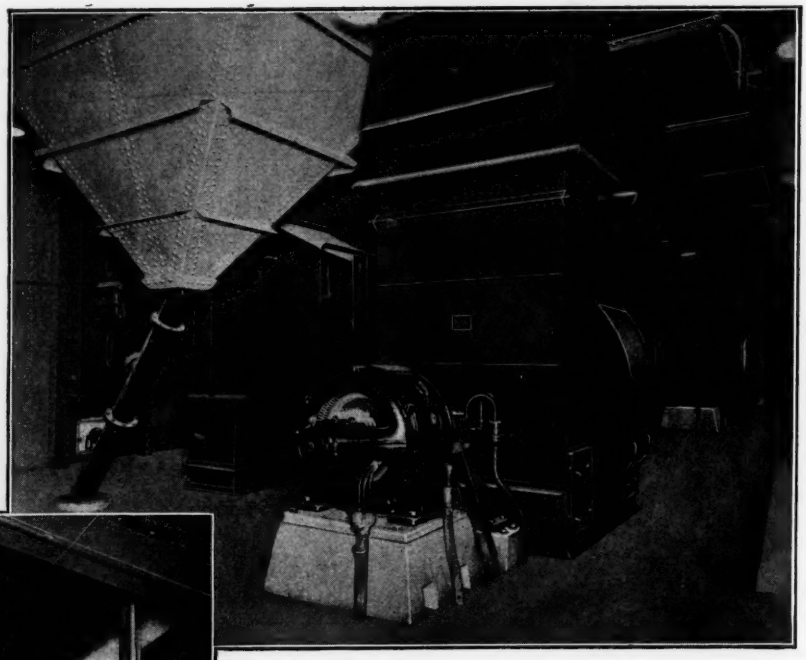
Condensers: surface; low level jet; barometric; distilling. Coolers: for oil, water and all liquids. Expansion joints: crosshead-guided and internally-guided. De-aerators; Evaporators; Heat exchangers. Heaters: bleeder, high and low pressure; boiler feed, chemical, hot water system, oil, storage, sugar juice. Strainers: duplex, continuous service type.

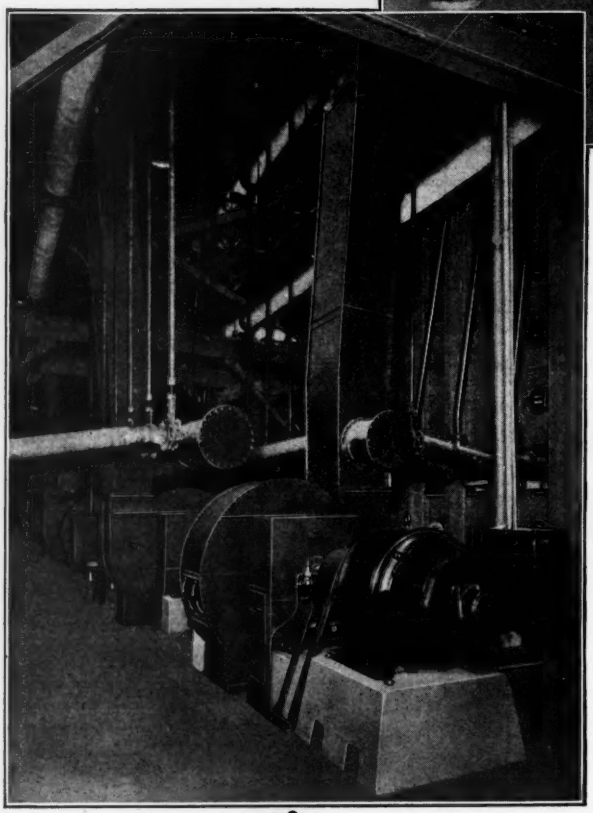
ROSS HEATER & MFG. CO., Inc., Buffalo, N.Y.
Agents in all principal cities

Industry's Testing Ground

Today every piece of equipment that goes into the industrial power plant is a dollars-and-cents factor in the cost of the finished product.

That's why industrial concerns are so keenly interested in central station practice — because the central station is the N-th degree in power efficiency.





That also explains, in large measure, the ever-growing percentage of industrial users of Buffalo forced and induced draft fans—the fans which are installed in many of the largest and most efficient power plants in the world.

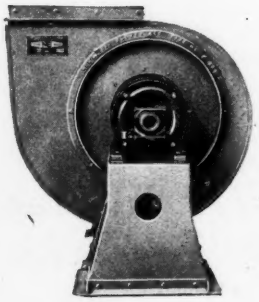
The upper illustration shows some of the eight Buffalo induced draft fans and eight forced draft fans installed at the new Columbia Power Station, Cincinnati. Lower, Buffalo Steel Plate Fans for supplying primary air at the same plant.

Buffalo Forge Company

188 Mortimer Street **Buffalo, N. Y.**

In Canada: CANADIAN BLOWER & FORGE CO., Ltd. Kitchener, Ont.

"Buffalo" **mechanical draft apparatus for results**



TYPE
ME
FAN

Tested and Certified!

The new type ME Fan has been thoroughly tested by competent disinterested engineers in the laboratories of two universities.

Architects and engineers will be interested to know as a result of these findings, that the ME Fan is unsurpassed in mechanical efficiency and performance by any fan of its type now on the market.

May we submit a portfolio showing these tests in detail, together with photographs of the apparatus used?

Fans
Unit Heaters
Air Washers
Blowers
Furnaces

NEW YORK BLOWER COMPANY

General Offices
2248
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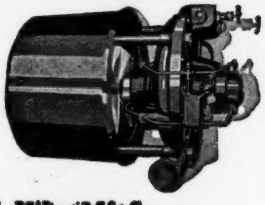
For Every Boiler Stokered or Hand-Fired



Wing Turbine Blower
The Original 1905
The Standard since 1905

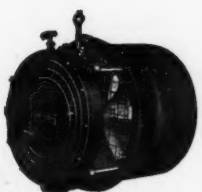
No Ducts-Low Cost.
More Capacity-Better Efficiency with any Fuel

L.J. Wing Mfg. Co.
659-669 Hudson St.
New York

Send for Bulletin 77 S.

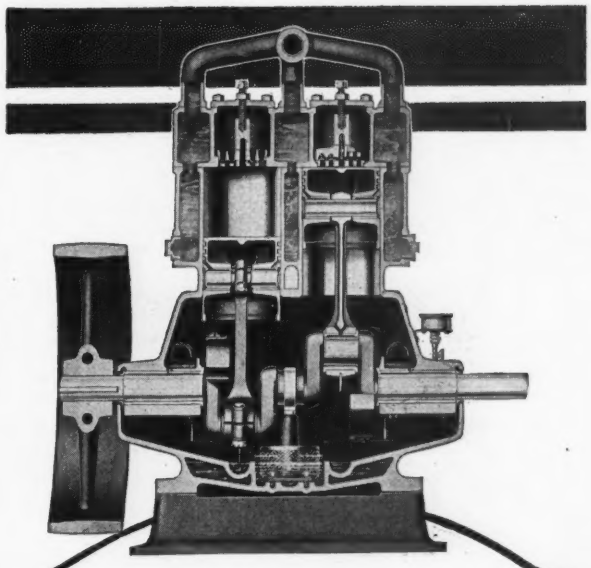
POOR DRAFT?
Coppus Forced Draft Blowers

at least double capacity of chimney and you may burn any kind of low priced fuel.



Coppus Engineering Corporation
340 Park Ave., Worcester, Mass.

Turbine Driven
Read Bulletin 145



AUTOMATIC LUBRICATION
of the XH Compressor

Lubrication of the GARDNER XH Compressor is automatic and positive, insuring smooth operation and long life.

An abundant supply of oil is circulated to each main bearing by a plunger type oil pump. All other working parts are bathed in a fine spray of oil by means of splash pins on connecting rods. Oil troughs cast in the crankcase insure adequate lubrication even when compressor is not in level position.

Send for Bulletin XH-3

"Quality Builders for Over 65 Years"

The Gardner Governor Co.
Quincy, Illinois

CHICAGO 549 Washington Blvd.
HOUSTON 611 2d Nat'l Bk. Bldg.
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PHILADELPHIA 604 Arch St.
LOS ANGELES 684 Santa Fe Ave.
MUSKOGEE 323 Dayton St.
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GARDNER

QUIGLEY GAS-TITE BAFFLES

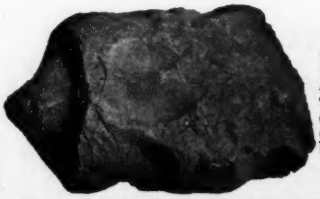
In Perfect Condition After 4 Years Although 70% of the Tubes Were Replaced

Four years ago a prominent contracting company installed a Quigley Gastite Baffle in a Power Plant at Jersey City, using a mixture of HYTEMPITE and Crushed Old Fire Brick. Since then 70% of the tubes have been removed and replaced without damage to the baffle.

Quigley Gastite Baffles bonded with HYTEMPITE stand up under forced firing, cling close to the tubes and don't develop cracks due to extreme temperature variations.

HYTEMPITE is universally used for laying up fire brick, patching, repairs, for building Monolithic Furnace Walls, etc. Ask for Bulletin 12A P.

Quigley Furnace Specialties Co., Inc.
26 Cortlandt Street **New York City**
Stock and Service in Every Industrial Center



"Walsh White" Fire Clay has qualities of hard "flint" with enough plasticity to be self-bonding.

Into the making of WALSH Brands *First Quality* Fire Brick

go the best of materials and workmanship. We have almost inexhaustible supplies of fire-clays of extraordinary quality.

"Walsh Tempered" Fire Brick is a "Stiff-Mud" brick of great heat-enduring qualities, capable of withstanding the destructive forces of cinders, clinkers and abrasive action or corrosive slags. Write for bulletin "A Fire Brick Brief."

WALSH FIRE CLAY PRODUCTS CO.
4070 N. Main St.
St. Louis
New York
Chicago

One of our friends—

states that he produced a saving of $14,000 in boiler furnace maintenance with the

CEMENT-GUN
TRADE MARK

during the first year of operation in his plant.

Consider that this is equal to the interest at 7% of a capital investment of $200,000. Furthermore the initial cost of the "CEMENT-GUN" is less than $1400, which represents only 10% of the total amount saved.

CEMENT-GUN COMPANY, INC.
ALLENTOWN, PENNA.

CEMENT-GUN CO., INC.
Allentown, Pa.
Gentlemen :—
Please send us full information regarding the many uses of the "Cement-Gun" around the boiler plant.

Name .....

Address .....

We would also be interested in having your Contract Department give us quotations on lining bunkers and breechings, or for constructing "Gunite" Stacks around old steel stacks, or for repairing concrete and brick stacks.

Reg. U. S. Pat. Off. **THERMOLITH** Pats. Pndg.

The All Temperature Fire Cement

"Makes the Weakest Point the Strongest"

Write for Literature

Trade Mark
HARBISON-WALKER REFRACTORIES CO.
Worlds Largest Producers of Refractories
Pittsburgh, Pa. *U.S.A*

Webers No. 48
Insulating Cement

For high temperature service. Mix with water and apply. It sticks—even to hot surfaces. Great covering capacity makes it economical. Even after long service, can be broken up and used like new material. Write for a liberal sample bag and try it yourself.

INSULATING PRODUCTS CORP., NEW YORK
INSULATING PRODUCTS CO., CHICAGO

1417

Put a dozen barrels of RAMTITE on the scales one at a time. The pointer will come to rest each time very close to 575 lbs. It won't vary 10 lbs. up or down. If you think RAMTITE is "Just another monolithic lining" try weighing a dozen barrels of any ordinary competitive material.

There IS a difference!

Even in filling the barrels, RAMTITE uniformity is in evidence. An air hammer packs the material in place, insuring proper content of the barrel and providing additional mulling.

EXACT control of raw materials and manufacturing processes insures this uniformity in the weight of RAMTITE. There is no variation in the refractories used nor in the calcining and mulling which they receive. Every step is under perfect control and obviously the result is "Uniformity."

What are the benefits of this uniformity to you?

FIRST—Accuracy of estimates. You know every cubic foot of space will require 130 lbs. of RAMTITE and no more. Our copyrighted calculator enables you to determine quickly and surely how much RAMTITE you need.

SECOND—Elimination of sags in the wall. When plastic material is called on to support material of greater weight, it tends to give way and permit a sag that opens up cracks and leads to wall failures. RAMTITE prevents this.

It costs money to provide these and the other advantages of RAMTITE listed in the adjacent column, but they make it possible to install RAMTITE under a positive guarantee.

Send the coupon today for full information on

Ten Important Advantages of RAMTITE

1 Made of virgin refractories.
2 Thoroughly milled and kneaded.
3 Uniform in weight.
4 Shipped in air tight wooden barrels. Convenient and safe.
5 Easy to install.
6 Certain in results.
7 Withstands fluctuating temperatures.
8 Cuts frequency of shut-downs for repairs.
9 Low cost of maintenance.
10 Long life.

RAMTITE

The S. Obermayer Company
2563 W. 18th Street
Chicago, Illinois

Manufacturing Plants:
Chicago Pittsburgh
Cincinnati Springfield, Mass.
Carried in stock in 26 cities

This Sample Can is *FREE*

This 5-lb. can of RAMTITE is sufficient to make a hot patch which will show you the merits of this "different" plastic lining in your own furnace. Send the coupon now.

Please send me the RAMTITE book and the 5 lb. sample can.

Name .....

Company .....

Address .....

The S. OBERMAYER COMPANY
2563 West 18th Street, Chicago, Ill.

PPE 12-15 Russell T. Gray, Inc.

Two Linings or One?

Which is the most profitable to the power plant? If you paid half as much for one kind of fire brick that lasted half as long as another kind, you would still be out money on your linings, wouldn't you?

Time and expense while boiler is shut down, old lining torn out and new lining laid up are the big costs on furnace linings.

Our brands of fire brick, placed into service in thousands of plants during the last 90 years, are made to endure.

"Q. R. GLASS" linings often last three times as long as ordinary fire brick linings.

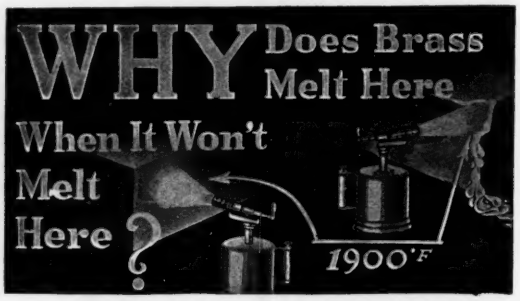
Stand up in flat arches. Uniform and free from shrinkage, pitting, spalling. Resist abrasion. Ideal for high temperatures.

Write for "Catalogue," and your copy of "Some Interesting Facts."

Queen's Run Refractories Co., Inc.

Lock Haven, Pa.

Boston Office: 141 Milk St.
New York Office: 15 Park Row
Philadelphia Office: 602 Harrison Bldg.



A Simple Convincing Test

1900° F. (the melting point of brass) when applied to the corner of a brass cube, melts it. Confining the heat to a small section and applying it from two sides, the brass is quickly heat-soaked, melts and runs. The same heat applied to one flat surface will not melt the brass because the heat is evenly diffused and quickly reflected.

Just so with the fire brick wall of your boiler setting. The many joints open up, allow the heat to attack the corners, the brick soon become heat-soaked, fuse and run.

BETSON'S PLASTIC FIRE BRICK

Withstands over 3100° F. Heat can only attack one surface, is quickly reflected and spread, thus eliminating most of the usual furnace troubles. Makes permanent, monolithic-no-joint-walls. The original, genuine Plastic refractory lining.

"If it isn't Betson's, it isn't Plastic Fire Brick"

Comes in distinctive yellow top metal barrels. Stocked in all large cities, ready to use. Order now.

Two Factories: Rome, N. Y., and St. Louis, Mo.

Betson Plastic Fire Brick Co.

P.O. Box 386-1, Rome, N. Y. 3040-1 Locust Blvd., St. Louis, Mo.

ADAMANT
FIRE BRICK CEMENT
Reg. U. S. Pat. Off.

This book contains many suggestions that will help you lengthen fire brick life. Write for a copy.

BOTFIELD REFRACTORIES COMPANY
776 S. Swanson St., Philadelphia, Pa.
Distributors in All Principal Cities

See full page **ADAMANT** *advertisement in the previous issue of "Power Plant Engineering"*

Repairing furnaces or setting boilers?

GET the price of doing the job the double-life Plibrico way. All over the country, we maintain expert repair crews who install Plibrico Furnace Lining. Or your own men can put it in if you prefer. Ask to have one of our 85 engineers call to figure with you.

PLIBRICO JOINTLESS FIREBRICK COMPANY
World's largest manufacturers of plastic lining
1836 Kingsbury Street, Chicago, Illinois
Factories: Chicago and Trenton, N. J.

There are now [illegible] installations of DETRICK ARCH [illegible] service. The experience gained [illegible] number of furnace problems [illegible] efficiency and lasting service in [illegible] own furnace problems.

M. H. [illegible] Company
Chicago
140 S. Dearborn Street
New York: 50 Church St. Pittsburgh: Empire Bldg.

STEEL MIXTURE
REG. U.S. PAT. OFF.

Boiler-Door Arches
Fire Box Lining
Back Arches (for h.r.t. boilers)
Flat Suspended Furnace Arches
Air-Cooled Furnace Walls
Standard Fire Brick
High-Temperature Cement

Write for Booklets

McLEOD & HENRY CO.
Main Office and Works: TROY, N. Y.
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LITTLEFORD BREECHINGS

Send Us your Specifications or Blue Prints for Quotation

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TANKS

SHEET AND PLATE STEEL CONSTRUCTION

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LITTLEFORD BROS.
451 EAST PEARL ST.
CINCINNATI, OHIO.

Since 1884

American

Brick Chimneys Boiler Settings

American Chimney Corporation
147 Fourth Avenue
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Branches:
Boston Cleveland Philadelphia
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FOR all power plant and industrial requirements.

Designed and erected by men of 26 years' experience.

Let us solve your chimney problems. No obligation for sketch and cost estimate. Write for new catalog.

Turner Baffle Walls

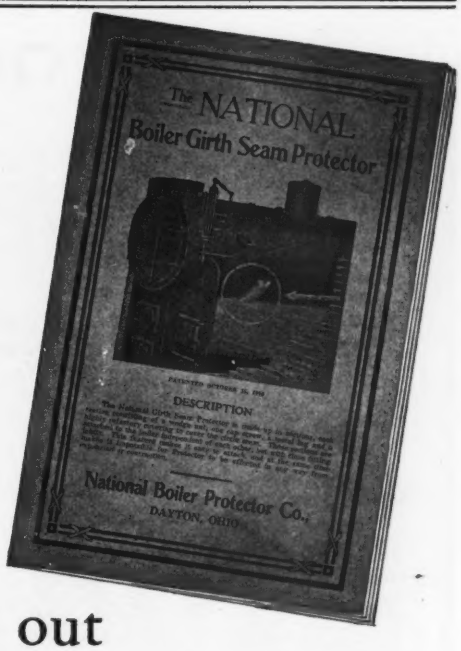
Produced exclusively by The Engineer Company

By the use of the corrugated TURNER BAFFLE TILES in the alleys between the tubes and filling the intervening space with TURNER PLASTIC CEMENT, tamped in place by hand—flexible, enduring, gas-tight and trouble-free baffles result.

Every TURNER BAFFLE WALL is specially designed for the boiler in which it is used.

Consultation invited. Write for Bulletin.

THE ENGINEER COMPANY
17 Battery Place, New York City



Find out *what others say* about NATIONAL Girth Seam Protectors

12,000 satisfied users

Sent on 30 Days' Free Trial

Here are two extracts from hundreds of letters from users:

"Protector which we purchased from you a year ago has been in continuous service and has been entirely satisfactory."

"We had a seam in one of our fire tube boilers which gave us endless trouble. We had this caulked and riveted and riveted and caulked. We could not do away with the leak. Several months ago we put one of your seam protectors on this seam and have been entirely free from trouble ever since."

Get 32-page catalogue for full description and other letters.

National Boiler Protector Co.
740-741 Reibold Bldg., Dayton, Ohio, U.S.A.
Eastern Office: 70 Exchange St., Rochester, N. Y.

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Paterson, N. J., 473 Getty Ave.
Philadelphia, Pa., 1321 S. Ringgold St.
San Francisco, Cal., 334 Monadnock Bldg.
Havana, Cuba, Calle Aguiar 71, Dpto. 402
Greenville, S. C., Box 662
Montreal, P. Q., Coronation Bldg., 121 Bishop St.
Shanghai, China, P. O. Box 749

Send for Bulletin No. 83

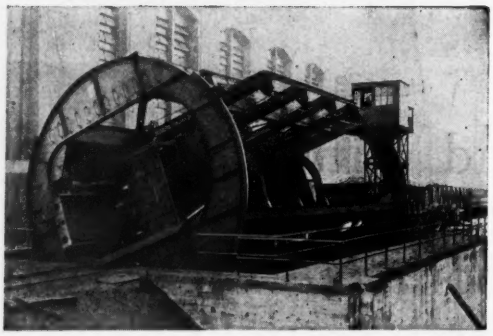
Only One Operation with the W-S-M *Revolving Car Dumper*

Unloading coal by hand is slow, tedious and involves an unnecessary expense that would soon pay for a scientific car dumper.

W-S-M Revolving Car Dumpers are economical and eliminate this expense.

Faster, too, dumping 120-ton capacity cars continuously at an average of one every two to three minutes.

Built in lengths of 30, 40, 50 and 60 ft. for handling cars from 6 ft. 6 in. to 13 ft. high and from 9 ft. to 10 ft. 9 in. wide and loaded capacities up to 320,000 lb. gross weight.



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The Koppers Co. for Bethlehem Steel Co.
The Koppers Co. for Commonwealth Edison Co. (2 plants)
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Utah Copper Co. (2 machines)
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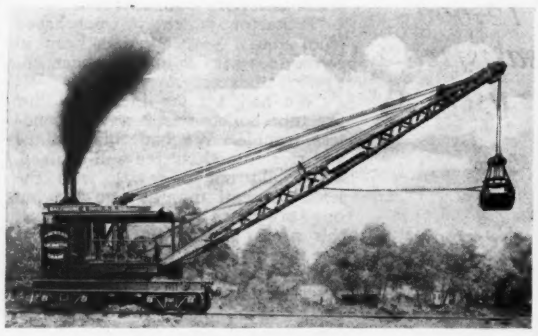
Dodge Mfg. Co.

The Wellman-Seaver-Morgan Co.

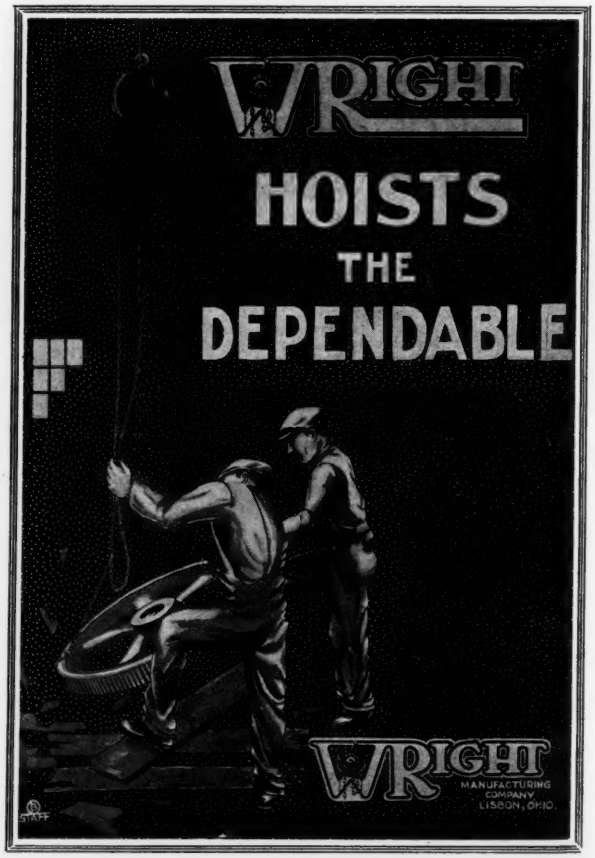
7003 Central Ave., Cleveland, O., U. S. A.

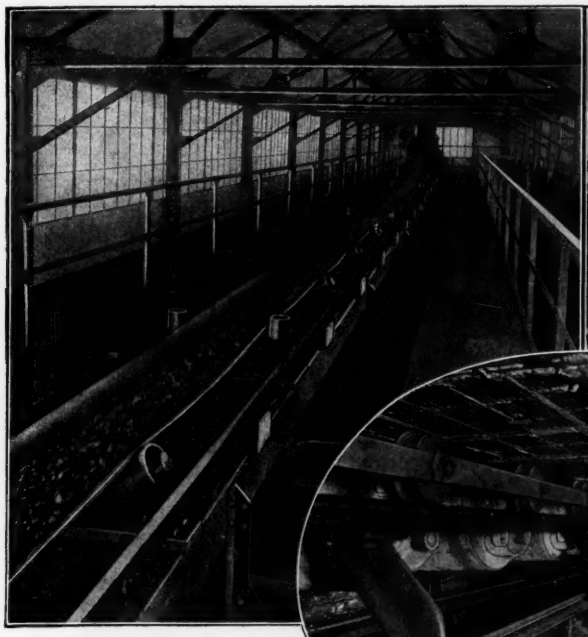


They Offered Two Other Cranes for One "AMERICAN"

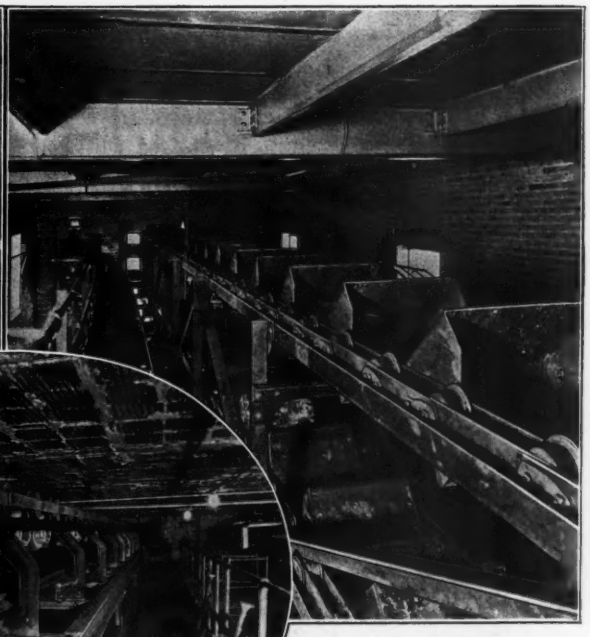
That the "AMERICAN" Locomotive Crane fully measures up to the dependability and efficiency requirements of large power companies is well illustrated by the action of one owner. This concern bought an "AMERICAN." After using it for a while they were so convinced of its money-saving ability that they offered to trade in TWO cranes of competing make for ONE more "AMERICAN." Start out with "AMERICANS" and you will have no regrets.

AMERICAN HOIST & DERRICK CO.
Saint Paul, Minn.
New York, Chicago, Pittsburgh, Seattle, St. Louis, New Orleans

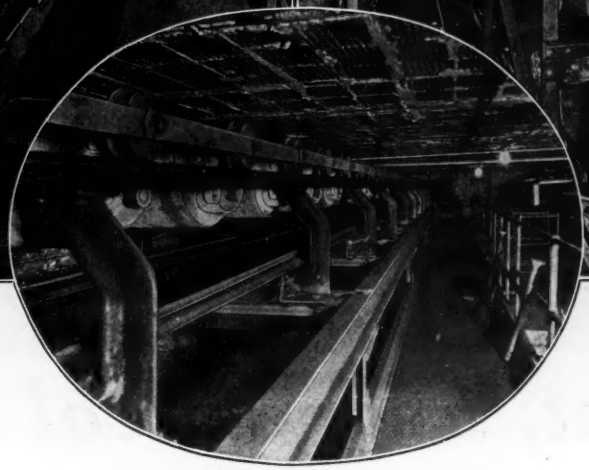




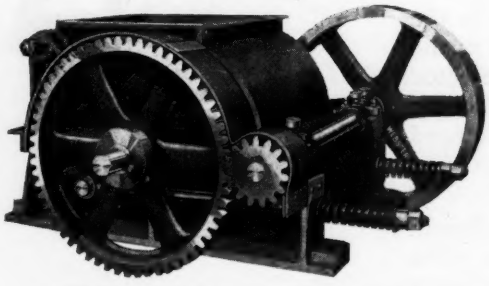
Belt Conveyors Distributing Coal to Bunkers



Gravity Discharge Elevator-Conveyor Handling Coal



Pivoted Bucket Carrier for Handling Coal and Ashes



Webster Single Roll Coal Crusher
Reduces Mine Run to Stoker Size in one operation

The Proper Method and the Proper Equipment for handling your coal and ash handling job can both be supplied by The Webster Mfg. Company. Webster designs and builds various types of equipment, including track hoppers, feeders, coal crushers, pivoted bucket carriers, belt conveyors, bucket elevators, gravity discharge elevator-conveyors, weigh larries, flight conveyors, ash skip hoists, coal bunkers and stoker spouts.

We will be glad to confer with you on your coal and ashes handling problem.

Our Engineering Department is at your Service.

THE WEBSTER MFG. COMPANY

1856 North Kostner Ave.
CHICAGO

BOSTON BUFFALO CINCINNATI CLEVELAND NEW YORK PHILADELPHIA PITTSBURGH

WEBSTER

Efficient, Economical Ash Handling

Ashes raked into the intake opening at the boiler front are transported rapidly in a single operation to a cast-iron storage tank, illustrated above.

THE American Steam Ash Conveyor transports ashes from the boiler room to the ash pile or storage tank in a single dustless operation. A steam jet in the metal pipe transportation line establishes suction in the intake section. The steam jet itself acts as an ejector on the discharge section of the line. Ashes are fed into intake openings in front of each boiler and discharged in a loose, easily handled condition into a car, storage bin, or disposal heap.

No extra labor is required with the American Steam Ash Conveyor. The fireman opens the throttle valve on the steam jet and dumps or rakes ashes into the suction line. Steam is used only when the conveyor is in operation. The cost of steam per ton of ashes is unusually low.

For installations where a large volume of ashes, sized coal, or other such materials are to be handled the AroCarrier is recommended. The AroCarrier conveys granular materials by suction induced by a steam jet or exhaust pump. STEAM DOES NOT COME IN CONTACT WITH THE CONVEYED MATERIAL.

Let us give you complete information on these economical methods of ash handling.

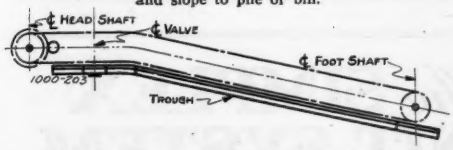
Conveyors Corporation of America
326 W. Madison Street, Chicago

PPE 10-15 GRAY Engineering sales offices in principal cities.

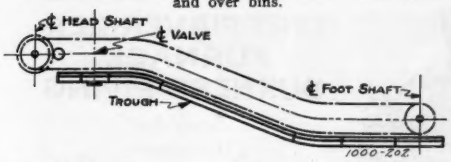
Irregular Outline No Handicap

Horizontal Conveyor for along ground or over storage bins.

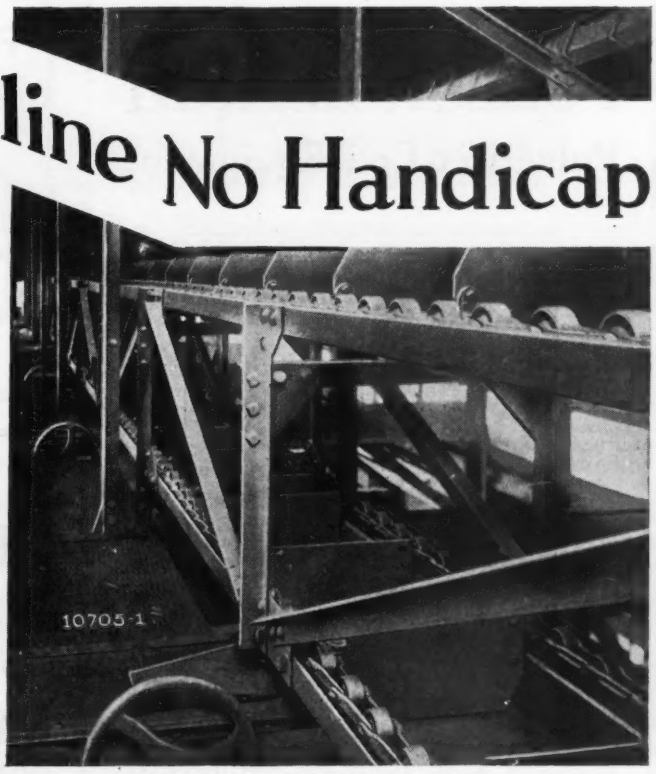
Combination Conveyor, horizontal receiving section and slope to pile or bin.



Combination Conveyor, up slope from receiving hopper and over bins.



Combination Conveyor, receiving section up slope and over storage.



for the Jeffrey Scraper Conveyor

IN a power plant of moderate capacity with an awkward, irregular outline for the coal handling conveyor — inclined, horizontal or a combination of the two— you have a job for a Jeffrey Scraper Conveyor.

It's an easy conveyor to install and is reliable.

Can be loaded at any point. Discharges anywhere by means of one or more valves placed in the carrying trough.

Our Engineers will appreciate an opportunity to help you solve your problem.

Ask for the bulletin showing the Scraper Conveyor and seven other methods of coal handling.

The Jeffrey Manufacturing Company

North Fourth St., Columbus, Ohio

New York, Buffalo, Rochester, N. Y., Philadelphia, Pittsburgh, Scranton, Pa., Boston, Cincinnati, Cleveland, Detroit, Chicago, Charleston, W. Va., Milwaukee, St. Louis, Denver, Salt Lake City, Los Angeles, Birmingham, Charlotte, N. C., Montreal

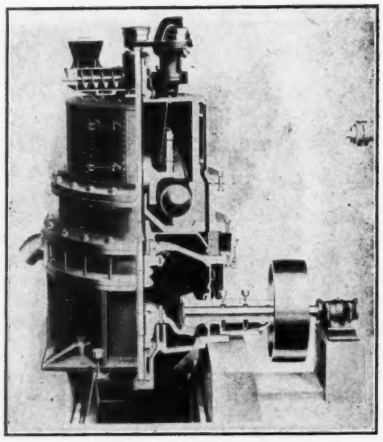
JEFFREY
MATERIAL HANDLING EQUIPMENT

Jeffrey Products

Elevators—Conveyors
Portable Loaders
Coal and Ashes Handling Equipment
Skip Hoists
Chains and Attachments
Sprocket Wheels—Gears
Crushers—Pulverizers
Sand and Gravel Handling, Washing, and Screening Equipment
Locomotives
Coal Mine Equipment
Tipple Equipment
Ventilation Fans

FULLER-LEHIGH

Pulverized Coal Equipment



Fuller-Lehigh Pulverizer Mill, Screen Type, Gear-Driven

Fuller-Lehigh Pulverizer Mills, built in either screen or air separation types, are in successful operation in many plants, both in this country and Europe.

A few plants using Fuller-Lehigh Pulverizer Mills:

Binghamton Light, Heat & Power Co., Binghamton, N. Y.
Broad River Power Co., Parr., S. C.
Clark Thread Co., Newark, N. J.
Columbia Power Co., Cincinnati, O.
Queensboro Gas & Elect. Co., Far Rockaway, L. I.
American Chain Co., York, Pa.
Dominion Sugar Co., Wallaceburg, Ont., Can.
Trumbull Steel Co., Warren, O.
New Orleans Public Service, Inc., New Orleans, La.
Colorado Fuel & Iron Co., Pueblo, Colo.
U. S. Coal & Coke Co., Gary, W. Va.
Penna. Water & Power Co., Holtwood, Pa.

Write for these Bulletins.

No. 900 Pulverized Coal for Boilers Central Storage System.

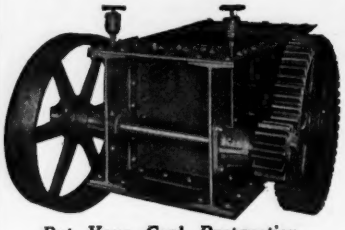
No. 800 Pulverized Coal for Direct Firing of Boilers.

FULLER-LEHIGH CO., Fullerton, Pa.

(A Babcock & Wilcox Organization)

New York, Fuller-Lehigh Co., 50 Church St.
Chicago, Acers-Poppenhusen Co., McCormick Bldg. 332 So. Michigan Avenue
Boston, H. H. Leathers, 80 Federal St.
Salt Lake City, Harrison & Co., Atlas Block

"PENNSYLVANIA" *STEELBUILT* ARMORFRAME CRUSHERS



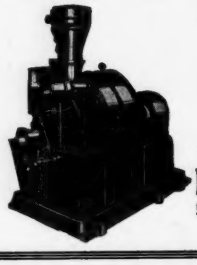
are specialized for properly preparing R. O. M. Bituminous coal for modern stokers and pulverizers in Industrial Power Plants, Gas Works and Central Stations, with unfailing dependability.

PENNSYLVANIA CRUSHER COMPANY

Put Your Coal Preparation Problems Up to Us

Liberty Trust Building
Broad and Arch Streets
Philadelphia

The SIMPLEX UNIT SYSTEM



UNIT PULVERIZER
FURNACE
BURNERS PIPING

Send for Literature

FURNACE ENGINEERING CO. INC.
5 BEEKMAN ST. NEW YORK, N.Y.

HAGAN STEAM JET ASH CONVEYORS

The Proven Economical Method of Ash Disposal.

HAGAN — INDUSTRIAL FURNACES FOR ALL PURPOSES

Write for Complete Information

GEORGE J. HAGAN COMPANY
CHAMBER OF COMMERCE BLDG. PITTSBURGH, Pa.

Can You Afford to Overlook Economies Effected in Such Plants as These?

COLUMBIA Station — The Columbia Power Co., Columbia Park, O.

FISK ST. Station — Commonwealth Edison Co., Chicago, Ill.

PHILO Station — Am. Gas & Electric Co., Philo, O.

TWIN BRANCH Station, American Gas & Electric Co., Mishawaka, Ind.

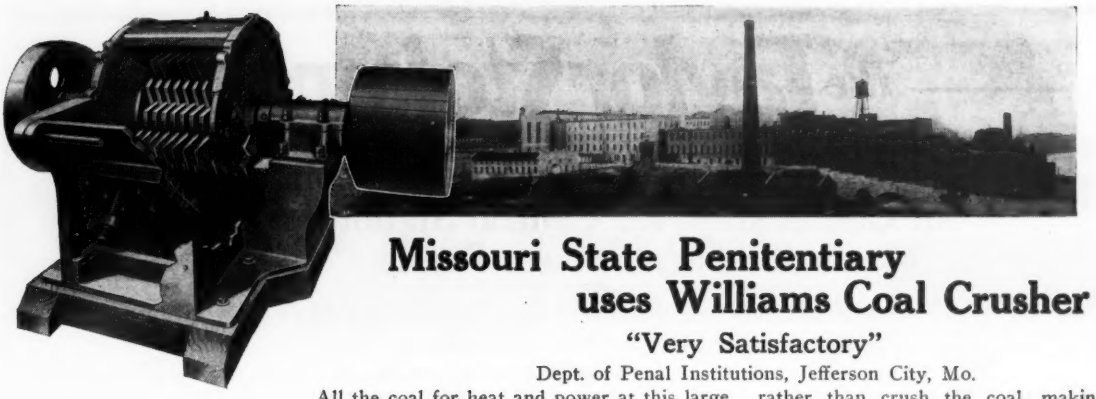
PEORIA Station, Illinois Electric Power Co., Peoria, Ill.

These and hundreds of others use

American *Ring* Crushers

to reduce R. O. M. coal to stoker size and for pulverizers. Write.

American Pulverizer Co. 18th and Austin Sts., St. Louis, Mo.



Missouri State Penitentiary uses Williams Coal Crusher

"Very Satisfactory"

Dept. of Penal Institutions, Jefferson City, Mo.

All the coal for heat and power at this large institution housing and employing approximately 3,000 inmates is crushed to stoker size with a Williams hammer coal crusher.

Because of the patented hammers which split rather than crush the coal, making fewer fines, Williams crushers are used by many of the largest power plants in the country, including Detroit Edison Co., United Railway Co., St. Louis, Standard Oil and many others. 12 sizes. Write for printed matter.

We also build the

Little Giant Grinder for Old Fire Brick and Asbestos

Williams Patent Crusher & Pulverizer Co.

700 St. Louis Ave. St. Louis, Mo.

Chicago 37 W. Van Buren St. | New York 15 Park Row | San Francisco 415 5th Street

THE WILLIAMS PATENT CRUSHER & PULVERIZER CO. ST. LOUIS MO. U.S.A. TRADE MARK

REG. U.S. PAT. OFF.

Williams

ORIGINAL PATENTEES AND WORLD'S LARGEST BUILDERS OF HAMMERMILLS

PATENT CRUSHERS GRINDERS SHREDDERS

ANOTHER BIG INSTALLATION OF ARMSTRONG BOILER GRATES

United States Gypsum Company installs a total of 2096 Square Feet of Grate Surface as a result of a Trial Installation of ARMSTRONG SHAKING GRATES

Merit tells, always! U. S. Gypsum wanted a grate equipment that would give better results with less coal. They wanted a grate equipment that would be low in upkeep expense as well as fuel cost. They wanted a grate equipment that would be more efficient; more economical; more satisfactory in every way.

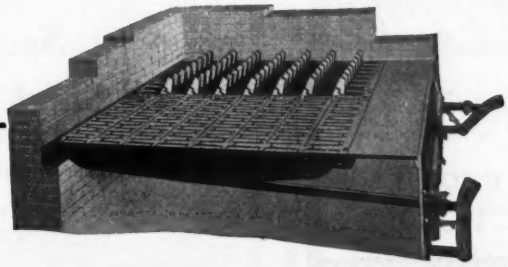
In the ARMSTRONG SHAKING GRATE they found all these things.

This is an Interlocking grate. The fingers of one grate pass through the openings between the fingers of the adjoining grate. The air spaces are formed by the openings between these interlocking fingers. A shaking lever is conveniently located on the boiler front. A forward and backward shaking of this lever opens every air space—sifts out fine ashes—overcomes clinker formations—insures a constant and ample flow of air through the fuel bed.

The result is a fuel saving of from 15% to 25% and an increase in boiler steaming capacity of from 25% to 40%.

WRITE FOR OUR THIRTY-DAY TRIAL PLAN

You don't have to take our word for it—you don't even assume any obligation to purchase these grates until you have tried them out in your own furnace for thirty days. If they don't sell themselves to you on their actual performance—take them out and send them back.



Shaking Grates
Hand-fired Stokers
Automatic Stokers

Gasoline Locomotives
Grey Iron Castings
Semi-Steel Castings

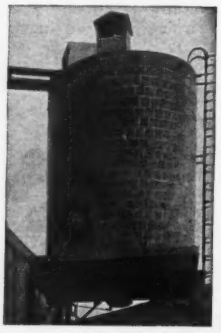
ARMSTRONG MFG. CO., 615 W. Liberty Street, SPRINGFIELD, OHIO

The Taylor Stoker

The Simplest, most Efficient, most Economic System of Combustion for Central Stations and Industrial Power Plants

AMERICAN ENGINEERING COMPANY
Kensington Station, PHILADELPHIA, PA.

Canadian Sales and Service by AFFILIATED ENGINEERING COMPANIES, Ltd.
Head Office: Southam Bldg., MONTREAL, QUE.



Keep Clean Boiler Rooms

With a simple turn of a valve remove ashes the easy, inexpensive, clean Brady way.

The Brady Conveyors Corporation
20 W. Jackson Blvd.
Chicago, Ill.

Manufacturers of

BRADY Steam Jet Ash Conveyors
***and Vitrified Tile* Ash Hoppers**

ASH

Hydrojet Ash Sluicing Systems
Water Collecting Ash Gates
Cast-Iron Ash Hoppers
Tanks and Coal Bunkers

ALLEN-SHERMAN-HOFF COMPANY
257 South 15th Street, Philadelphia

DETROIT UNDERFEED STOKERS

Ask For Bulletin 879

Detroit Stoker Company
879 General Motors Bldg - Detroit.

NEEMES GRATES

Neemes Grates make it easy to maintain clean, even and smokeless fires. Even with the worst of coal, combustion goes on with maximum economy. In hundreds of plants Neemes Grates are continuously giving this economical and reliable service to satisfied users.

NEEMES FOUNDRY, Inc.
186 First Street Troy, N. Y.
Manufacturers of Round and Square Grates
Established 1874

ECONOMY QUALITY 1874 NEEMES SERVICE

Get the Most out of your Refuse Fuels

The designs of National Stokers and Furnaces make them especially adaptable to burning refuse fuels, providing maximum economy, the highest efficiency and smokeless operation. Often enough additional steam is obtained to avoid the installation of a new boiler. In some instances the use of coal or oil is eliminated.

THE M. A. HOFFT CO.
816 Washington Avenue, Indianapolis, Ind.
For Canada—National Stokers—Riley Eng'r'g & Supply Co., Ltd.,
380 Dufferin St., Toronto

NATIONAL STOKERS ··· NATIONAL ARCHES

SPRINGFIELD BOILERS

Sectional
All Steel Water Tube

Springfield Boiler Co., Springfield, Ill.

OFFICES:

Chicago	Pittsburgh	Cincinnati	New Orleans
New York	Richmond	Minneapolis	Dallas
Boston	Atlanta	Duluth	Los Angeles
Philadelphia	Detroit	Kansas City	San Francisco
			Seattle

Why KELLY IMPROVED HAND STOKERS

Save 10 to 25 per cent of the coal bills - -

THOROUGH combustion is insured on Kelly Stokers by the provision of ample air through a great number of small openings, which do not change in size when bars are operated for cleaning and carrying fuel bed forward.

This feature enables Kelly Hand Stokers to burn anthracite screenings, coke breeze, wood refuse, etc., with practically no carbon siftings into the ash pit and without smoke.

The shearing action of the grate bars which are alternately raised, and the close mesh between the stationary grate bars positively cuts and removes all clinkers, keeping clean grates and a high rate of combustion.

Fuel passes through successive stages of combustion by manipulation of the easily operated outside levers which move it gradually down the grates to the dumping plate, at a 4½-inch incline.

High combustion rates and ability to burn cheap grades thoroughly easily produce savings of 10 to 25 per cent in fuel bills.

Can you afford to overlook this investment?

The Kelly Foundry & Machine Co.
617 Ninth Street, Goshen, Ind.
POWER PLANT ENGINEERS
Established 1887
New York Office 59 Park Place
Chicago Office 111 W. Washington St.

WHEN YOU BUY
KELLY STOKERS-GRATES GOSHEN IND.
YOU BUY RESULTS

Easy to install ~ Easy to operate

HUBER STOKERS

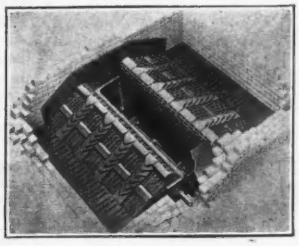
Mechanical Stoker Hand Stoker (heavy duty)
Semi-Mechanical Stoker Hand Stoker

A Stoker for Every Boiler

Send for a copy of
"Five Minutes With the Coal Bill"

FLYNN & EMRICH COMPANY
307 North Holliday Street Baltimore, Maryland

The HART STOKER
has these Five Special Features:



1. The Central Retort Stoker that positively distributes the fuel over the entire grate surface.
2. Necessary agitation of the coking coal is near the crust of the fuel bed.
3. Hart Renewable Tuyeres prevent stratifying or jetting air currents.
4. Air system arranged in zones permits a definite relation of air to fuel supply.
5. Flexibility of operation that is automatically controlled.

Write for Bulletin

The Hart Stoker, Ltd., Weightman Bldg., Phila., Pa.

BURKE STOKERS

"Burn Cheap Coal—
and Less of It"

Mechanical Stokers
Burke Furnaces
U. S. Grates

Write for literature

BURKE ENGINEERING CO.
Tribune Tower CHICAGO HOLLAND MICHIGAN Sloan Building CLEVELAND

High Operating Efficiencies

are the principal factors in the selection by leading industries of the

Laclede Chain Grate Stoker

Write to the Laclede Stoker Co., 4438 Hunt Ave., St. Louis, Mo., and get full information on why they also show

Low Maintenance Costs

LOPULCO FIRES NEW

$1,750,000 ELECTRIC PLANT READY

U. W. CO-ED TO THROW THROTTLE OPEN

Lakeside Addition to Be Placed in Service Tomorrow.

Completion of a 37,000 kilowatt addition to Lakeside power plant, installed at a cost of $1,750 000, was announced today by John Anderson, vice president of The Electric Co., in charge of power.

The new equipment, consisting of an immense boiler and two turbo-generators, is capable of supplying the entire Sunday demand for electric service in Milwaukee and all of eastern and southern Wisconsin.

It will be placed in service at 10 a. m. tomorrow during a brief ceremony in which Miss Miriam Anderson, daughter of The Electric company official, will demonstrate her ability to follow her father's footsteps.

PUBLIC INVITED.

Miss Anderson, the only woman mechanical engineering student at the University of Wisconsin and one of the few young women in the world to aspire to that profession, will open the throttle that puts the gigantic machines to work, it is announced.

The public is invited to inspect the new units, together with the remainder of the power plant, during Open House Week, Nov. 8 to 13, Mr. Anderson said.

The additional units, one of which is a high pressure machine, will bring the total capacity of Lakeside, already the largest power generating station in Wisconsin, up to 167,000 kilowatts.

The boiler, the largest of its kind in the world, will generate steam under pressure of more than 1,200 pounds per square inch as compared to a pressure of three hundred pounds employed in nearly all other stations in the country.

The high pressure section, it is explained, is designed to operate in connection with the lower pressure equipment, making an unusually efficient combination.

The use of the higher pressure is considered as revolutionary in steam power practice as was the use of powdered fuel for which the Lakeside station became world famous six years ago. Electric company officials believe high pressure operation will be followed in other plants just as the use of powdered coal has been.

ADDS TO EFFICIENCY.

The heat in steam becomes more useful under higher pressure, thereby increasing the efficiency of the installation, Mr. Anderson explained.

"The high pressure steam will be used in a special new turbine where it will expand in twenty separate steps down to the pressure of the other turbines, where it will be used over again," he said.

"The steam pressure of the new boiler is sufficient to lift four adults, could their weight be concentrated on a 2-cent piece. Water released from this boiler through an efficient firehose nozzle would spurt 3,000 feet into the air, or fifteen times the height of the Majestic Building.

Combustion Corpora
International Combustion Building
200 Madison Ave., (Entrances on 35th & 36th Sts.) New York
A SUBSIDIARY OF INTERNATIONAL COM

WHIGH PRESSURE BOILER

Six years ago Lakeside was a center of great interest over results secured through Lopulco Pulverized Fuel Systems.

Today interest centers on the new high pressure boiler installed at Lakeside.

This high pressure boiler is fired by

The Lopulco Pulverized Fuel System

in conjunction with

C-E Furnace Walls

and

C-E Air Heaters

INTERNATIONAL COMBUSTION ENGINEERING CORPORATION

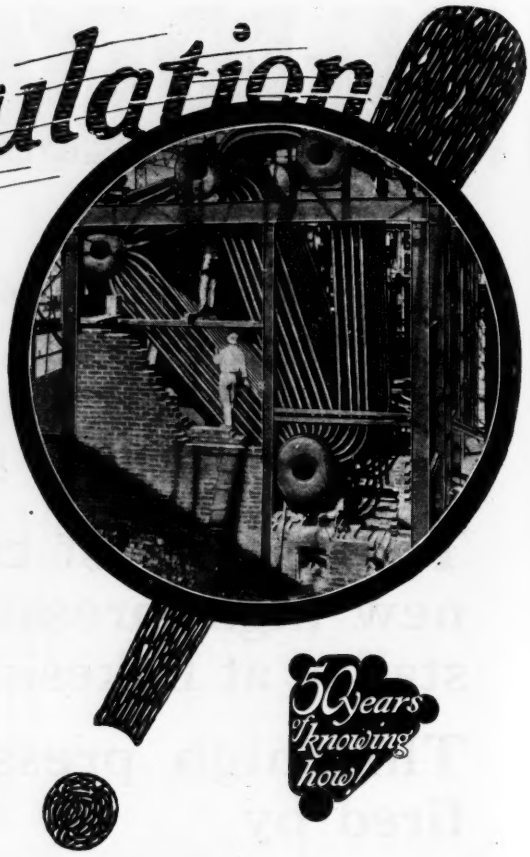
- ✓ Lopulco Pulverized Fuel System
- Frederick Multiple Retort Stoker
- Self-contained Stoker
- Coxe Stoker
- Type E Stoker
- Type D Stoker
- Type K Stoker
- Type H Stoker
- Green Natural Draft Stoker
- Green Forced Draft Stoker
- ✓ C-E Fin Furnaces
- ✓ C-E Air Heaters
- ✓ C-E Unit System (Pulverized Fuel)
- Grieve Grates
- Combusco Ash Conveyors
- Quinn Oil Burning Equipment
- Combustion Steam Generator
- Ladd Water Tube Boilers

Engineering

oration *Offices throughout the World*

NAL COMBUSTION ENGINEERING CORPORATION

Rapid Circulation



The free and unrestricted circulation provided by the full tube area in the path of water travel found in the Connelly maintains even temperature in all parts of the boiler, eliminates steam pockets and prevents unequal expansion stresses.

50 Years of knowing how!

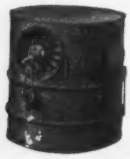
THE D. CONNELLY BOILER CO.
1170 Ivanhoe Road **Cleveland, Ohio**

UNION BOILERS

For nearly forty years the **Union Iron Works** have been concentrating in the development and manufacture of high pressure steel boilers exclusively and offer the Union Water Tube Boilers in both the horizontal straight tube longitudinal and cross drum designs and the vertical bent tube types, for pressures up to 400 lbs., in practically all sizes.

Also makers of Horizontal Return Tubular and Union Universal Fire Tube Boilers, having one of the largest and most modern boiler manufacturing plants, with sales representatives in all principal cities to serve you.

UNION IRON WORKS ERIE, PA.



Ljungström AIR PREHEATER

NEEDED IN EVERY BOILER PLANT

70% of the heat in the stack gases is returned to the furnace, with the following results:

1. Fuel tonnage decreased about 15%.
2. Boiler efficiency and capacity increased.
3. CO_2 raised.
4. Cheapest fuels burned.
5. Ideal furnace conditions.

SEND FOR OUR BULLETINS

THE AIR PREHEATER CORPORATION
25 Broadway, New York

Remarkable Efficiencies

Shown by

BADENHAUSEN (Patented)
Boilers
Preheaters
Superheaters
Water Cooled Furnace Walls

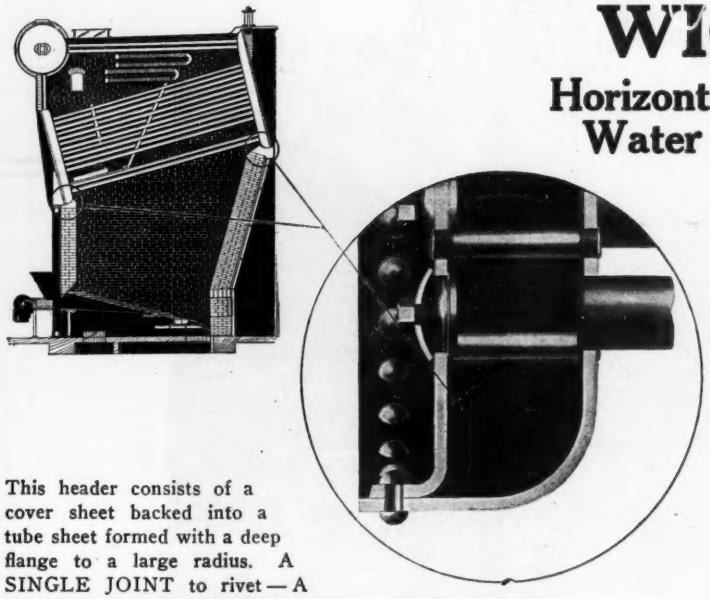
Each a unit in itself, yet an integral part of the boiler proper
Surveys and Tests by outside Engineers forwarded on request

BADENHAUSEN CORPORATION
General Office and Works
Cornwells Heights, Bucks County, Pa.

Improved Header Construction

WICKES

Horizontal Cross Drum Water Tube Boiler



Economy
Dry Steam
High Ratings
Straight Tubes

Write for free descriptive literature.

This header consists of a cover sheet backed into a tube sheet formed with a deep flange to a large radius. A SINGLE JOINT to rivet — A SINGLE JOINT to caulk. No seam to expose to the hot gases. Depth of headers proportioned to prevent counter currents. Hydraulic machine-riveted. The very best—an ideal header—Designed and Patented by WICKES.

The Wickes Boiler Co.
Saginaw, Mich.

SALES OFFICES:
New York, 501 Fifth Ave. Chicago, 33 So. Clark St.
Seattle, 736 Henry Bldg. Pittsburgh, 1218 Empire Bldg.
Detroit, 1116 Penobscot Bldg.

PL

The C-H Water Tube Boiler

All Steel Construction

Vertical or Horizontal Baffle, inside type forged steel handhole plates. Units of any size for any purpose. We also build Horizontal Tubular and Marine Type Boilers.

The Casey-Hedges Company
Chattanooga
Branches in all principal cities

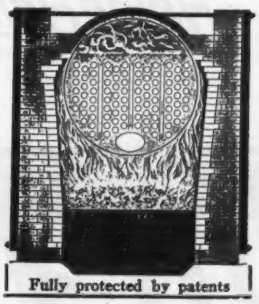
C-H Standard Water Tube Boiler

WEBSTER BOILERS

DEVELOP HIGH OVERLOADS—

50% Guaranteed

Howard J. Webster, Engineer
702-4 Harrison Bldg.
Philadelphia, Pa.



Fully protected by patents

"Circulation the basis of true boiler efficiency"
is proven by

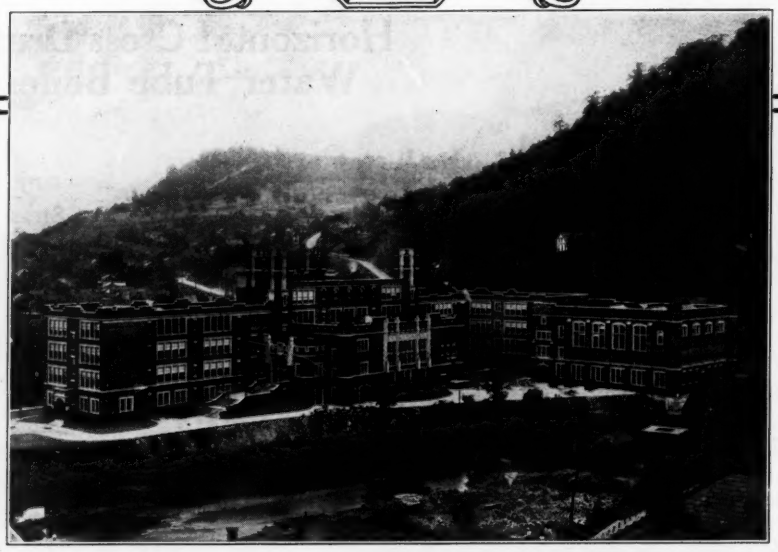
Nuway Boiler performance

70° differential between uptake temperature and corresponding steam temperature at rating. Under 600° at 300% of rating at 150 lb. W. P.

Write for Operating Data
Built from 50-350 H. P.

NUWAY BOILER & ENGINEERING CO.
53 W. Jackson Blvd., Chicago, Ill.

HELIOS



HEINE BOILERS

The installation of three Heine Long-drum Boilers in the Central High School, Johnstown, Pa. [pictured above] is merely typical of the widespread use of Heine equipment. Heine Boilers, Built by Heine, are furnished in all types, ratings and capacities:—Long-drum, Cross-drum [either horizontally or cross baffled] and Bent Tube—in addition to special construction such as Water-cooled Arch Supports, Water-cooled Walls, etc. Advisory service and catalogues on request.

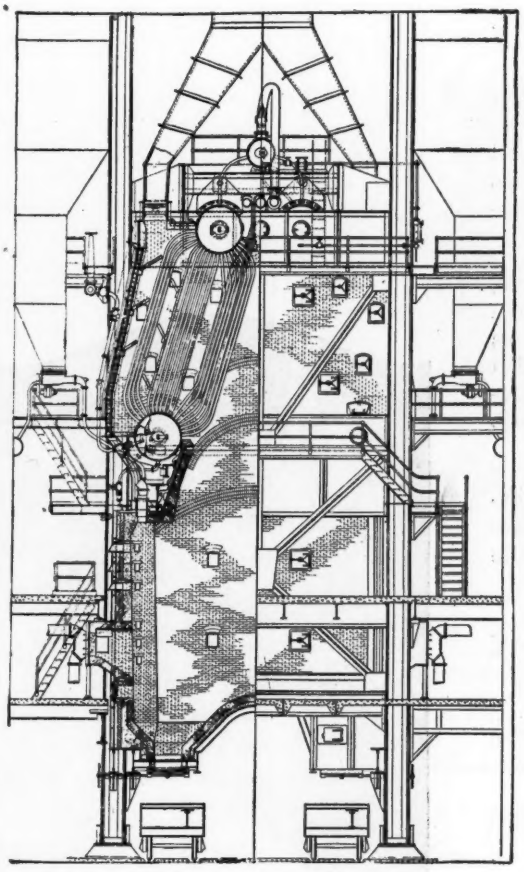
"Boilers Built by HEINE"

Boilers built by Heine are boilers built for superior performance. Correct design and workmanship that meets the most exacting requirements have always insured a product fully measuring up to the highest quality standards.

Heine Boiler Company
INCORPORATED
5319 MARCUS AVE. ST. LOUIS, MO.

Heine Boilers

EVERY INSTALLATION A SEPARATE ENGINEERING PROBLEM!



THE Ladd Water Tube Boiler has been developed to meet requirements of heavy duty and sustained overloads, and the design combines economy of operation and a small expense of upkeep with a great adaptability to all combinations of size, grade of fuel, pressure, overload capacity, superheat and space requirements.

Each installation is approached as a separate engineering problem and the various factors involved determine the details of the boiler offered.

Construction Features

All types built in accordance with the A. S. M. E. boiler code.

There are no hand hole plates used.

No stay bolts or flat surfaces.

Ample allowance is made for removing single tubes without disturbing any other tube.

All pressure parts of wrought or cast steel construction.

Every part of the boiler is accessible.

Suspension outside of brickwork carries all loads due to boiler, stack, superheater and thrust of arch.

All openings are effectively sealed against air leaks and provision is made for independent expansion of fire and common brick.

There are types for use with all kinds of fuel and the construction can be varied to suit any special conditions.

LADD WATER TUBE BOILER COMPANY

A Subsidiary of
International Combustion Engineering Corporation

FIRST NATIONAL BANK BUILDING, PITTSBURGH, PA.

NEW YORK OFFICE: 43 Broad Street

CHICAGO OFFICE: 528 McCormick Building

BEFORE YOU BUY THOSE BOILERS ~

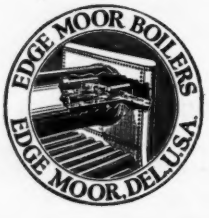
A BOILER is something that ordinarily you buy but once. A good boiler should last a life-time. Therefore, it is important to bear in mind your possible future power requirements when you invest in a new boiler.

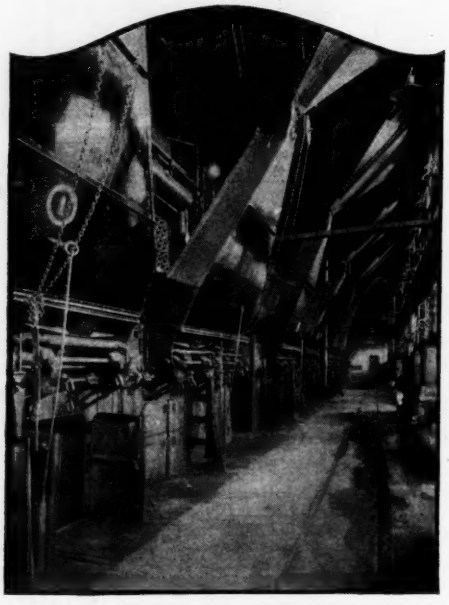
Before you are prepared to analyze your power requirements and to select the boiler which best fits those requirements, you must consider the whole cost of producing steam, including operation, maintenance and useful life.

A long list of nationally known concerns, which bought their first boilers on such a basis, have Edge Moor Boilers. As fast as they have made extensions, they have added more Edge Moor units, showing that their original selection was justified by performance.

In considering your new power plant or extensions to your present boiler room, you will find much helpful information in the Edge Moor catalog.

EDGE MOOR IRON COMPANY
Established 1868
EDGE MOOR, DELAWARE
New York Chicago St. Paul Boston
Pittsburgh Charlotte Los Angeles



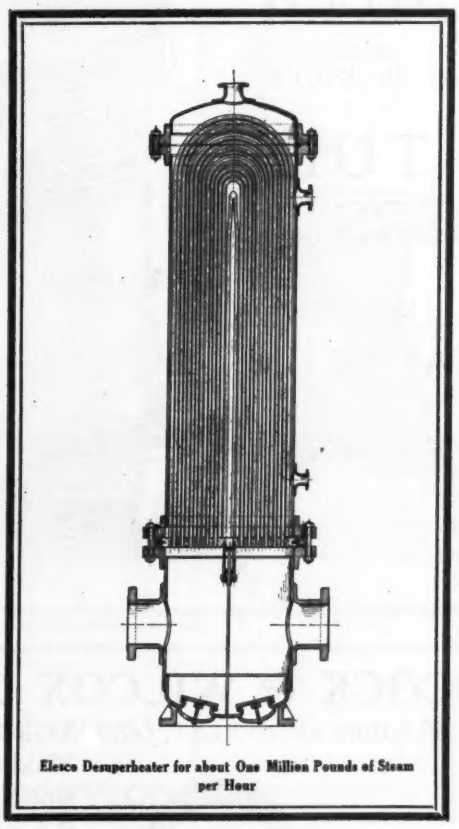


Twelve Edge Moor Boilers at United States Glue Co., Carrollville, Wis. Four of these boilers have been in continuous service for twenty-five years, and are still in excellent condition.

EDGE MOOR Water Tube BOILERS

FOR INCREASED FUEL ECONOMY

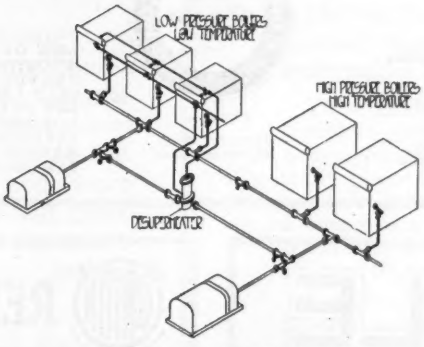
The DESUPERHEATER



Elesco Desuperheater for about One Million Pounds of Steam per Hour

Purposes

Elesco Engineering again expresses its advanced thinking in the Elesco desuperheater. It is an effective, interchangeable link between high pressure and low pressure boiler, prime mover and auxiliary operation. Automatic control of temperatures under varying steam requirements insures greater safety and opens up new possibilities in the use of steam for process work and general industrial purposes.



Typical Application of Elesco Desuperheater
Built as single units in capacities from 25,000 to 1,000,000 lb. steam per hr.
Further particulars on request

Features of the Elesco Desuperheater

The steam does not come in contact with the water

No danger of water reaching prime mover.

Accurate temperature control over entire range of steam requirement.

Corrosion of tubes avoided.

Minimum scale.

Contains minimum amount of heating surface.

THE SUPERHEATER COMPANY

17 East 42nd Street, NEW YORK

Peoples Gas Bldg., CHICAGO — ELESCO — Union Trust Bldg., PITTSBURGH

Represented in

Atlanta, Birmingham, Boston, Charlotte, Salt Lake City, Denver, Houston, Kansas City, Memphis, New Orleans, San Francisco, St. Paul

Canada: The Superheater Company Limited, Montreal

VERTICAL HEADER SECTIONAL FORGED STEEL

650 LBS. WORKING PRESSURE

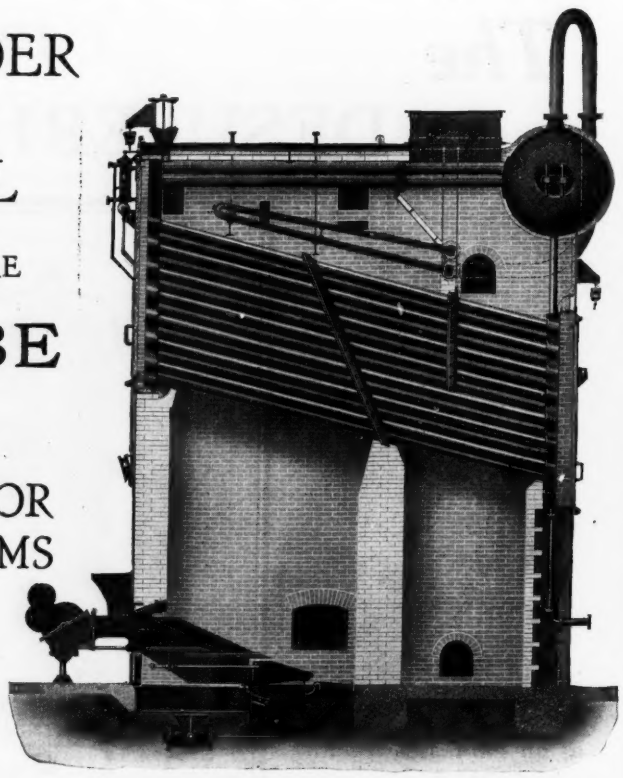
WATER TUBE BOILERS

WITH CROSS DRUM OR LONGITUDINAL DRUMS

THE WALSH & WEIDNER BOILER CO.

Chattanooga, Tenn.

Branch Offices in Principal Cities



THE BABCOCK & WILCOX COMPANY

85 LIBERTY STREET, NEW YORK

Builders since 1868 of Water Tube Boilers of continuing reliability

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PHILADELPHIA, Packard Building
PITTSBURGH, Farmers Deposit Bank Building
CLEVELAND, Guardian Building
CHICAGO, Marquette Building
CINCINNATI, Traction Building
ATLANTA, Candler Building
PHOENIX, ARIZ., Heard Building
DALLAS, TEXAS, 2001 Magnolia Building
HONOLULU, H. T., Castle & Cooke Building
PORTLAND, ORE., 805 Gasco Building

THE BABCOCK & WILCOX COMPANY — STEAM

Works
Bayonne, N. J.
Barberton, Ohio

Makers of Steam Superheaters since 1898 and of Chain Grate Stokers since 1893

BRANCH OFFICES

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NEW ORLEANS, 344 Camp Street
HOUSTON, TEXAS, 1011-13 Electric Building
DENVER, 444 Seventeenth Street
SALT LAKE CITY, 405-6 Kearns Building
SAN FRANCISCO, Sheldon Building
LOS ANGELES, 404-6 Central Building
SEATTLE, L. C., Smith Building
HAVANA, CUBA, Calle de Aguiar 104
SAN JUAN, PORTO RICO, Royal Bank Bldg.

ANDALE
Duplex Strainers

with Large Baskets—Globe Valves and tell-tale Rising Valve Stems—

for Straining Water and other liquids

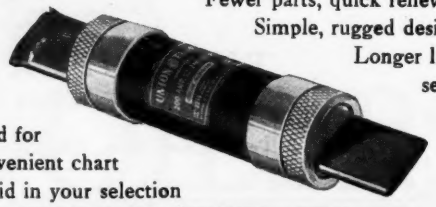
Write for Bulletin 125

Andale Engineering Co., 1600 Arch St. PHILADELPHIA

UNION

RENEWABLE FUSES

Fewer parts, quick renewal—
Simple, rugged design—
Longer life in service



Send for convenient chart to aid in your selection

CHICAGO FUSE MFG. CO.

1543 W. 15th St. CHICAGO, ILL.

Eliminate Costly Shutdowns EASILY!

HERE ARE JUST TWO of the long list of Green products, among which are Aurand Commutator Slotters, Emery 4 Cyclone Blowers and Vacuum Cleaners, L. & H. Turning and Grinding Tools, Acme Commutator Polish and Acme Armature Washing Fluid.

Acme Stones are made in any size or shape of standard quality and quickly grind and finish commutators and collector rings true and smooth.

Acme Cement is ready mixed, quick drying and non-conducting. It fills holes and pits and prevents grease and dirt accumulation between bars.

Hundreds of plants are users.

ACME STONES

GREEN EQUIPMENT CORPORATION
MONADNOCK BLOCK CHICAGO, ILLINOIS

Calebaugh Brushes *Do* Give Better Service

For Instance

After 20 months' service on a Westinghouse 1000 KW. Generator at one of the largest steel mills in Pennsylvania, a grade No. 712 Calebaugh Brush had worn but 5/16 of an inch, and had given perfect commutation without smutting or wearing of the commutator.

This is but one of the hundreds of instances where Calebaugh brushes have proved their superiority.

Have you a brush problem where we may be of service?

CALEBAUGH
SELF-LUBRICATING CARBON CO., Inc.
1503 COLUMBIA AVE. PHILADELPHIA

STOPPED!

A C-H Dean Valve Control Station. Red and green bull's eyes always indicate position of valve.

C-H Valve Units may be installed also on valves now in operation; in most cases without shutting down the line.

by this

Master of Emergencies

SHOULD high pressure steam be let into a cold line? Should human error or unauthorized tampering with the steam system cause any one of a score of emergency situations to arise in your plant? *Are you equipped to meet it?*

Do you have that split-second valve control from a *safe place* that meets emergencies before fairly started?

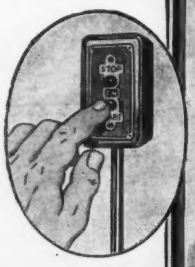
The C-H Dean Valve Control System gives complete, quick, remote control of valves from a central control panel or from conveniently placed individual C-H Control Stations. In either case, a touch of the finger instantly starts a valve to open or close. The actual time of closing is but a fraction of that required by hand.

Exclusive C-H features insure positive operation at all times, under all conditions.

In the every-day operation of the plant, C-H Dean Valve Control also makes a saving. The C-H booklet, "Modern Valve Control Practice," gives complete information. Have you read this interesting booklet? If not, write today for your copy.

The CUTLER-HAMMER Mfg. Co.
Pioneer Manufacturers of Electric Control Apparatus
1253 St. Paul Avenue
MILWAUKEE, WIS.

CUTLER C-H HAMMER
Dean Valve Control System



The trend of industry is decidedly toward Cutler-Hammer Push Button Control. Merely a touch of the proper button right at the machine starts, accelerates, decelerates, regulates the speed or stops the motor as required. The controller is placed in any safe, convenient location. Saves time, affords better control and provides greater safety—a logical step in advance.

This booklet "Industry's Electrical Progress" puts into concise, interesting form the story of savings through modern motor control. Write for your copy today.

Motors by themselves are only brute force

The economies that electric power brings to industry depend on correct motor control

IT seems so simple—and yet in so many plants this basic truth is often neglected.

Motors by themselves are only brute force!

Engrave it on the minds of the men who design *your* equipment. Burn it into the memory of those who specify—those who buy. For today it is the battle cry in the fight to reduce manufacturing costs!

Every motor you put into service offers the opportunity of minimum operating expense. It can save in power costs. It can speed up production. It can save in labor—that major item of manufacturing burden. But you are trifling with opportunity if you leave these possible economies to chance—these economies that result not from the mere installation of motors, but from the production efficiency you are able to obtain through the perfect control of their brute force.

Competitive conditions today demand the accurate powering of equipment. Plan your drives considering the work to be done. That means the choice of motor control equipment first—choice of the type of control equipment that affords maximum speed of production—that ties in closest with the manual operations involved. The proper type of motor can *then* be selected to give maximum results.

Carry this story to the men of your plant! Have them check the motors you have in service. Like many other plants, you will find that modern motor control on many existing drives will pay for itself in a few months—and then add steadily to profits.

If you desire, Cutler-Hammer field engineers will gladly counsel with your plant men or consulting engineers to determine where savings may be obtained—to show them the latest control equipment available for every need. Their recommendations are based on more than thirty years' experience. This service is also offered for the planning of new drives, and their co-operation does not place you under any expense or obligation.

The CUTLER-HAMMER Mfg. Co.

Pioneer Manufacturers of Electric Control Apparatus

1253 St. Paul Avenue **Milwaukee, Wis.**

CUTLER-HAMMER

Industrial Efficiency Depends on Electrical Control

This advertisement may be read by an engineer who understands electricity from A to Z. It may be read by an executive who knows little or nothing about it. Yet, both are interested in giving their plant equipment the finest protection they can secure.

U-Re-Lite has been built out of an experience that dates back over 38 years in the Circuit Breaker art. You can get nothing finer—nothing more dependable—nothing more economical and trouble-free in operation than U-Re-Lite—for absolute protection against the ever-present dangers of short circuits and electrical overloads.

A copy of the ninety-six page U-Re-Lite handbook will be mailed on request

CUTTER

U-RE-LITE I-T-E CIRCUIT BREAKERS

THE CUTTER COMPANY — *Established in 1888* — PHILADELPHIA, PENNSYLVANIA

There is Just as Much Difference

in internal combustion engines for standby as there is between shoes, hats, overcoats or anything in which you discriminate.

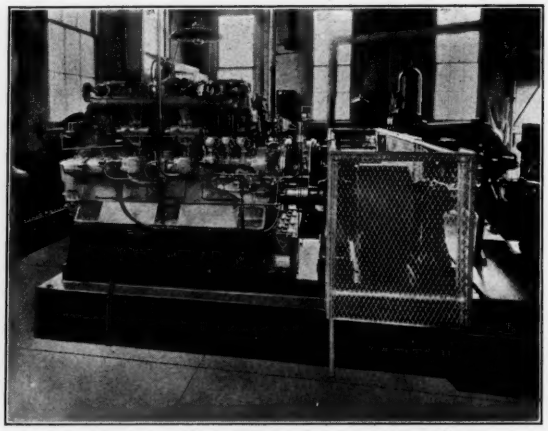
The specifications of the cheaper engines are dressed up like plausible oil stock and some engines are even made to look like

Sterling High Duty

Sterling

THE ENGINE OF REFINEMENT

Internal Combustion Engine



At Moorestown, N. J., De Laval 2 stage 6-inch centrifugal pump, 1000 G.P.M., 170 ft. head, 1160 R.P.M., driven by GRC-6 cylinder 175 H.P. Sterling, also belted to 112 KVA, alternator, 1150 R.P.M.

A small folder detailing the difference is yours for the asking

30 to 3000 H.P. at 1200 R.P.M.

STERLING ENGINE COMPANY, Dept. C-10, Buffalo, N.Y., U.S.A.

Kingsford-Webster Sectional Water Tube Boilers

All steel construction.
Built in all H. P. sizes for all pressures.

CROSS DRUM TYPE

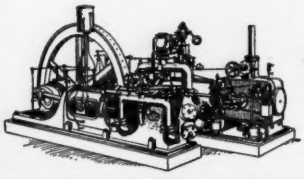
Kingsford Foundry & Machine Works
OSWEGO, NEW YORK

HIGH GRADE

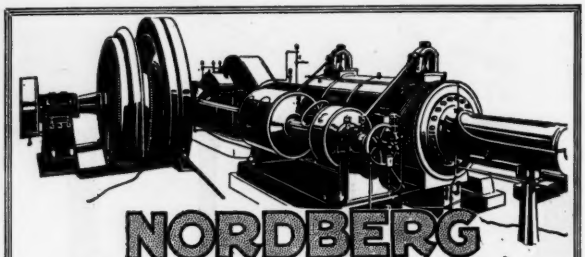
Corliss Engines

for belted or direct connected service

ICE MACHINES



Built by
The Vilter Mfg. Company
972 Clinton St.
Milwaukee, Wis.
Established 1867
Chicago Office
731 Monadnock Block

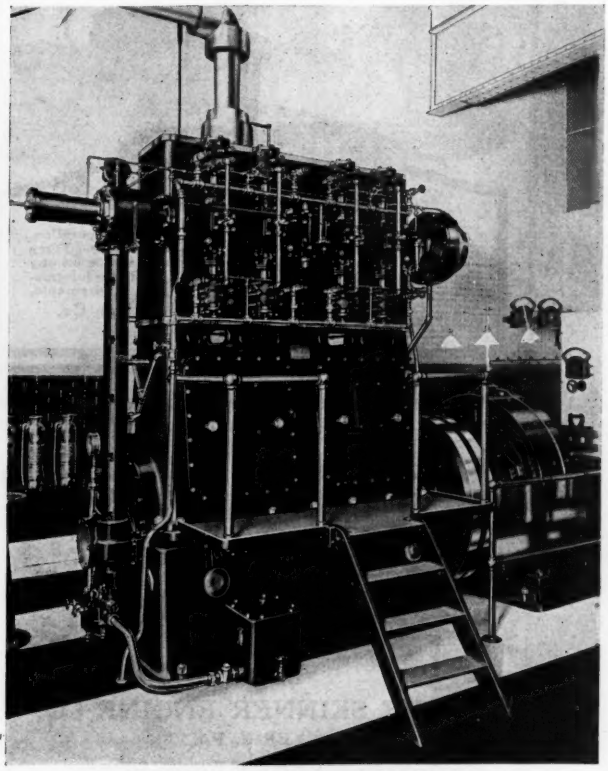


NORDBERG

UNIFLOW ENGINES MEET THE DEMANDS FOR POWER IN INDUSTRY

Bulletin RT-1 Describes Them

NORDBERG MFG. CO. MILWAUKEE, WIS.



200 K.W. Unit in Penal Institution

THIS

AMES Four Cylinder Vertical Una-Flow Engine

is now serving the third year of a life sentence at hard labor in the Middlesex County House of Correction, East Cambridge, Mass.

There is no less than 35000 H. P. more

in daily operation in other plants in U. S. and foreign countries.

Ames Una-Flow Engines

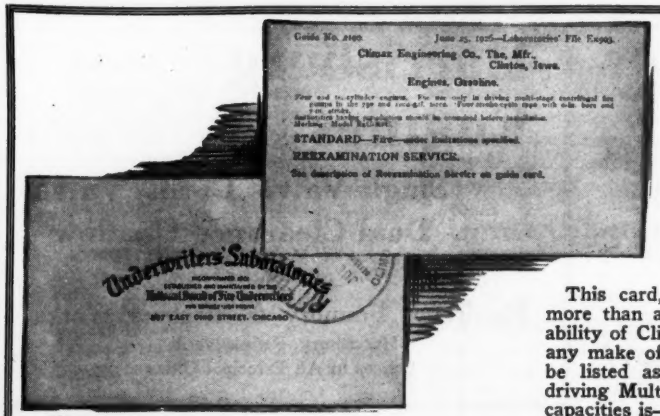
are also built in single cylinder horizontal type, for any desired service.

Bulletins sent on request.

Built by

AMES IRON WORKS, Division of Pierce, Butler & Pierce Mfg. Corp.
OSWEGO, N. Y.

High Pressure Power Boilers ***Low Pressure Heating Boilers***


Guide No. 2102 June 25, 1925—Laboratories' File E2903.
Climax Engineering Co., The, Mfr.,
Clinton, Iowa.
Engines, Gasoline.
STANDARD—Fire—water Resistance specified.
REEXAMINATION SERVICE.
See description of Reexamination Service on guide card.
Underwriters' Laboratories

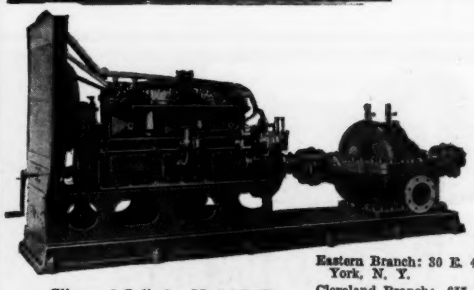
"A CARD of ADMITTANCE" to Your Plant

This card, issued by the Underwriters' Laboratories, means more than anything we can tell you about the proven dependability of Climax Engines. In selecting the Power for operating any make of Pump, remember that the first and only Engine to be listed as Standard by the Underwriters' Laboratories for driving Multiple-Stage Centrifugal Pumps of 750 and 1000 gallon capacities is—

CLIMAX Trade Mark Reg. U. S. Pat. Office

The "Trustworthy" Engine

Any Pump Manufacturer or his Agents will supply Climax Power if you specify it.



Climax 6-Cylinder Model R6U, with radiator mounted on cast iron side rails, with extended sub-base to which pump is bolted.

Write for Bulletin 1

CLIMAX ENGINEERING CO., 44 W. 18th Ave., Clinton, Ia.

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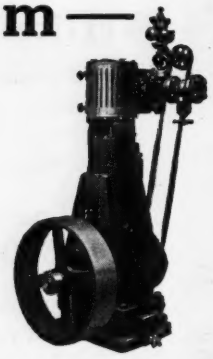
Cleveland Branch: 637 Leader Bldg., Cleveland, Ohio
Chicago Branch: 2007 Harris Trust Bldg., Chicago, Ill.
New Orleans, La.: Woodward, Wight & Co., 451 Howard St.
Southwestern Branch: P. J. Dasey, Hotel Wells, Tulsa, Okla.
Los Angeles, Calif.: Coast Machinery Corp., 464-66 E. 3rd St.
San Francisco, Calif.: Coast Machinery Corp., 829 Folsom St.
Birmingham, Ala.: Keiser - Geismer Engr. Co., 1308-9 American Trust Bldg.
Boston, Mass.: Rapp-Huckins, 59 Haverhill St.
Denver, Colo.: The Hendrie & Bolthoff Mfg. & Supply Co., 1621-39 17th St.
Indianapolis, Ind.: Carl Dunning Supply Co., 204 W. Maryland St.
Jacksonville, Fla.: Construction Equipment Co., 437 East Bay St.
Madison, Wis.: Wisconsin Machine & Foundry Co.
Minneapolis, Minn.: Wm. H. Ziegler Co., 619 Washington Ave, S.
Portland, Ore.: J. L. Latture Equipment Co., 354 Belmont St.
St. Louis, Mo.: Tulley Equipment Co., 2339 Pine St.
Omaha, Neb.: Interstate Machinery & Supply Co.
Montreal, Que., Can.: Edward C. Dingman, 1005 Keefer Bldg.

The Heart of the Boiler Room—

the stoker and fan drives—



That's where you need the power, compactness, dependability and ruggedness that's built into

Troy *Throttling Self-Oiling* Engines

Install this special unit to drive stokers and fans, that is built by specialists especially for the purpose, and forestall trouble, repairs and failures that may shut down the whole plant if less dependable units are used. Economical of steam and sold at a remarkably low price because of quantity production. Write for illustrated Bulletin H.

Type "S-H" 5 to 40 B.H.P.

—the ideal drive for stokers, fans, etc., as it has:

Minimum steam consumption,
Well-balanced strength in all parts,
Correct and permanent oiling system,
Low maintenance and operating cost.
Consult us.

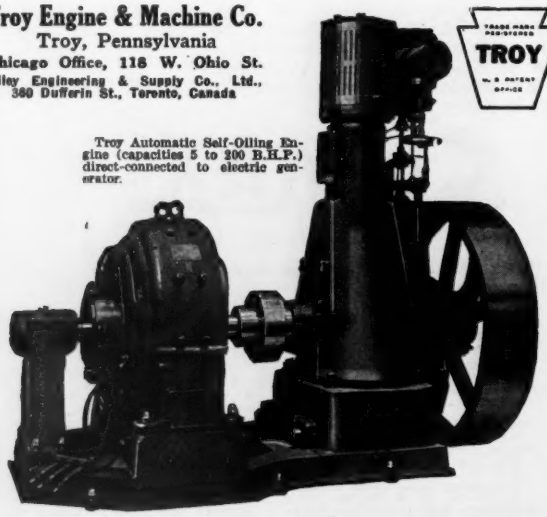
Troy *Automatic Self-Oiling* Engines

capacities to 200 B. H. P.

These engines are designed for heavy duty, close speed regulation and a high overall economy. They are the result of over 35 years' experience and specialization in building steam engines. Positively lubricated and completely enclosed. The oil pump is operated from the main eccentric and is absolutely dependable. Furnished to operate on 200 lb. pressure and high superheat.

Troy Engine & Machine Co.
Troy, Pennsylvania
Chicago Office, 118 W. Ohio St.
Riley Engineering & Supply Co., Ltd., 360 Dufferin St., Toronto, Canada

TROY



Troy Automatic Self-Oiling Engine (capacities 5 to 200 B.H.P.) direct-connected to electric generator.

THE TERRY TURBINE

More than 10,000 Terry Turbines now in operation. There is a type to meet your particular needs. Terry engineers are available for consultation and advice on any problem involving the use of a turbine. Write for information, stating your steam conditions and power requirements.

The Terry Steam Turbine Co.
Hartford, Conn.

The
"Universal Unaflow"

The Most Economical Steam Engine Ever Built

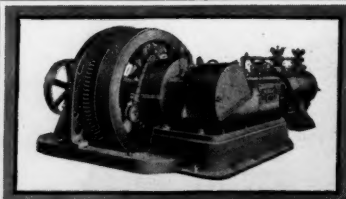
Built only by
THE SKINNER ENGINE CO.
ERIE, PA.
Branch Offices in all Principal Cities

Harrisburg Engines

Single Valve Corliss Valve
Dual Clearance Unaflow

Write for Bulletins now

Harrisburg Foundry & Machine Works
Harrisburg, Pennsylvania
Offices in All Principal Cities



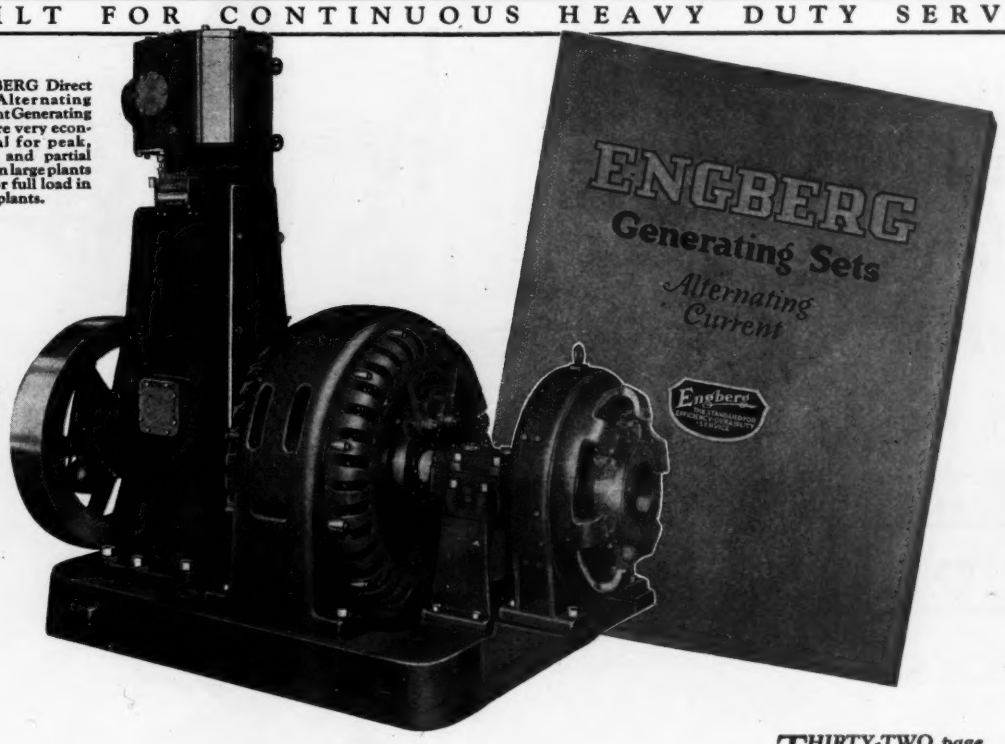
Tubular,
Water-Tube,
Internally-Fired
Boilers

Corliss & Una-Flow
ENGINES

Murray Iron Works Company Burlington, Iowa

BUILT FOR CONTINUOUS HEAVY DUTY SERVICE

ENGBERG Direct and Alternating Current Generating Sets are very economical for peak, night, and partial loads in large plants and for full load in small plants.



THIRTY-TWO page descriptive and illustrated bulletins will be sent on request.

No. 105, Direct Current Generating Sets,
No. 801, Alternating Current Generating Sets,
No. 302, Vertical, Enclosed, Self-oiling Engines,
No. 601, Direct and Alternating Current Generators.

A Few Users of ENGBERG Engines and Generators

American Seating Company
Standard Oil Company
Owens Bottle Company
Pet Milk Company
American Car & Foundry Company
Pennsylvania Railroad Company
Continental Motors Corporation
Champion Coated Paper Company
Koppers Construction Company
Atlas Portland Cement Company
Baxter Laundry Company
The Texas Company
Carnegie Steel Corporation
Ward Baking Company
Brown Shoe Company
Grasselli-Chemical Company
Central Leather Company
Yonkers Ice Company
Bear Brand Hosiery Company
United States Gypsum Company
New York Central Lines
American Steel & Wire Company
State of New York
Westinghouse Electric & Manufacturing Company
Ford Motor Company
The Palmolive Corporation
Northern Paper Mills
Baltimore & Ohio Railroad
Illinois Power Company
U. S. Steel Corporation
Buick Motor Company

ENGBERG'S ELECTRIC & MECHANICAL WORKS
814 Vine Street, St. Joseph, Michigan, U. S. A.

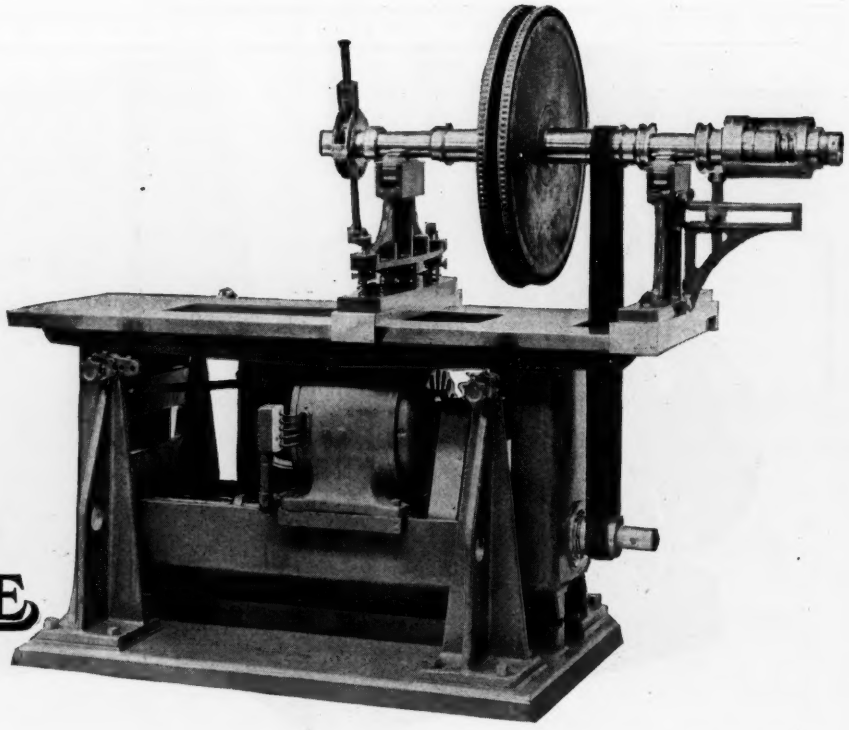
ENGBERG

Engberg
THE STANDARD FOR EFFICIENCY-DURABILITY-SERVICE

ENGINES
GENERATING SETS
GENERATORS
MOTORS
SWITCHBOARDS

THE RESULT OF THIRTY YEARS PRACTICAL EXPERIENCE

This machine balances vibration out of KERR TURBINE rotors



Kerr Turbine rotors are accurately balanced dynamically on the specially designed machine illustrated above. This machine is extremely sensitive and with it an accurately true balance is obtained.

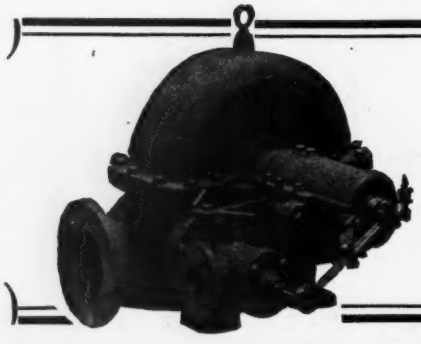
A balanced rotor running in heavy, cool bearings and supported by all-around rugged construction in every part of the turbine makes certain the smooth and reliable operation of Kerr Mechanical Drive Turbines.

TURBINE SALES DEPARTMENT
WELLSVILLE, N.Y.
DISTRICT OFFICES
ATLANTA, BALTIMORE, BOSTON, CHICAGO, CINCINNATI, DETROIT, CLEVELAND, NEW YORK, KANSAS CITY, ST. LOUIS, PHILADELPHIA AND PITTSBURGH
EXECUTIVE OFFICE - PITTSBURGH, PA.

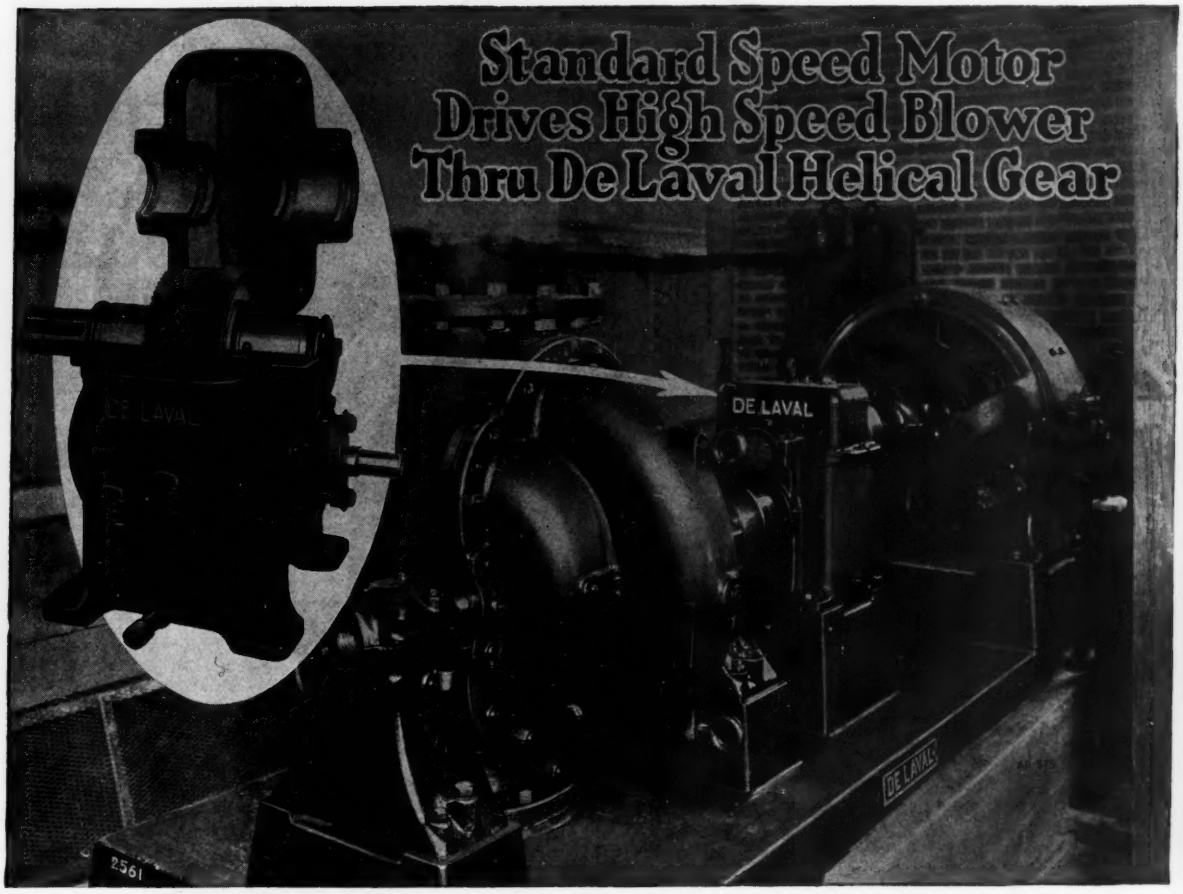
ELLIOTT COMPANY

H-497

PRODUCTS
STEAM TURBINES, REDUCTION GEARS, DEAERATORS, HEATERS, CONDENSERS, AIR EJECTORS, AUTOMATIC & NON-RETURN VALVES, BLOW-OFF VALVES, GREASE EXTRACTORS, STRAINERS, SEPARATORS



KERR TURBINES
for
mechanical drive



THE cupola blower shown delivers 5600 cu. ft. per min. against 31 inch water column pressure, running at 4000 r.p.m., although the driving motor speed is only 1000 r.p.m. By using De Laval speed transforming gears, standard speed motors or internal combustion engines can be employed for driving moderate and high speed machinery. These compact, self-lubricated gears require no attention further than maintaining the proper oil level.

De Laval

Steam Turbine Co., Trenton, N.J.

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Charlotte
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LOCAL OFFICES:

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San Francisco
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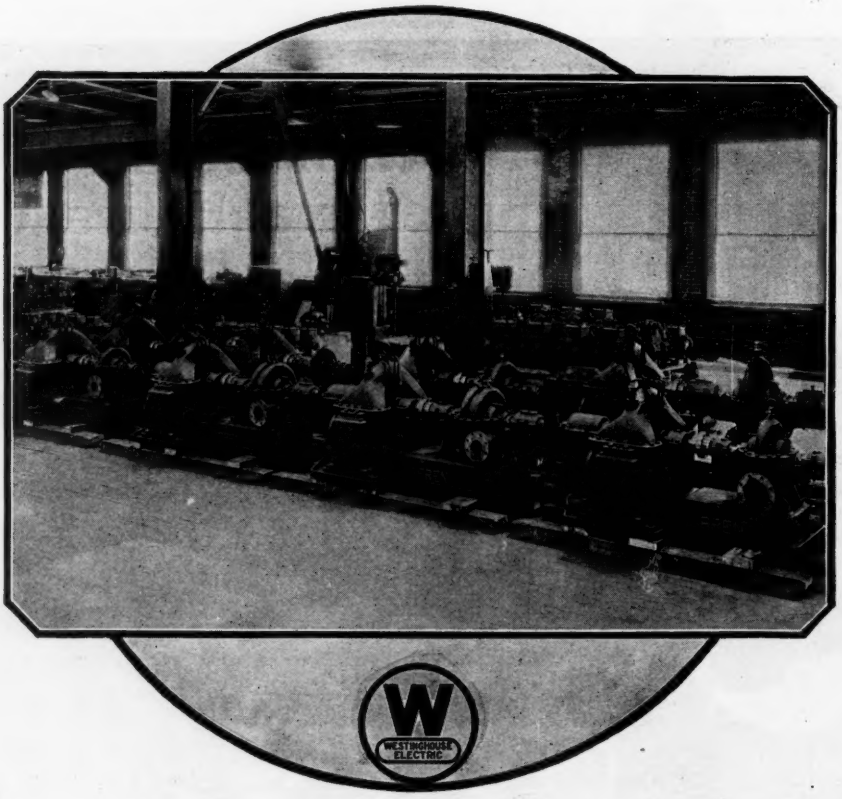
Spokane
Toronto
Vancouver

575

Manufacturers of Steam Turbines, Centrifugal Pumps, Centrifugal Blowers and Compressors, Double Helical Speed Reducing Gears, Worm Gears, Hydraulic Turbines, Flexible Couplings and Special Centrifugal Machinery



Serving the World's Largest Gas Holder

IN the illustration here shown are eight centrifugal pumps, each driven by a Westinghouse Mechanical Drive Turbine.

These pumps, manufactured by the Warren Steam Pump Company, Warren, Mass., are for varied service and operate at different speeds and against widely varied heads.

They serve as auxiliaries in the illuminating gas-making machines that operate in connection with one of the world's largest gas holders (capacity 15 million cubic feet) installed by the Public Service Production Company for the Public Service Electric and Gas Company.

The range, flexibility and efficiency of Westinghouse Mechanical Drive Turbines enable them to successfully meet almost any condition of pump drive service.

Westinghouse Electric & Manufacturing Company
South Philadelphia Works South Philadelphia, Pa.
Sales Offices in All Principal Cities of
the United States and Foreign Countries

Westinghouse

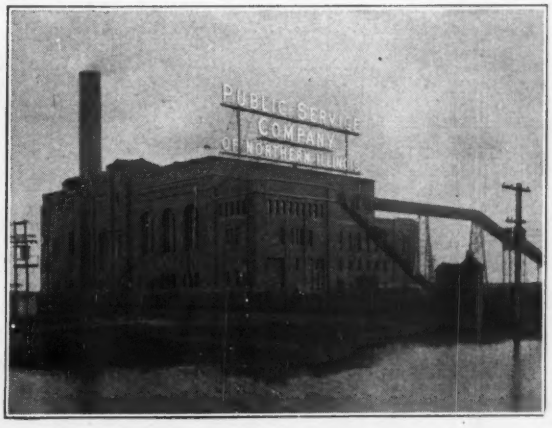
X88826

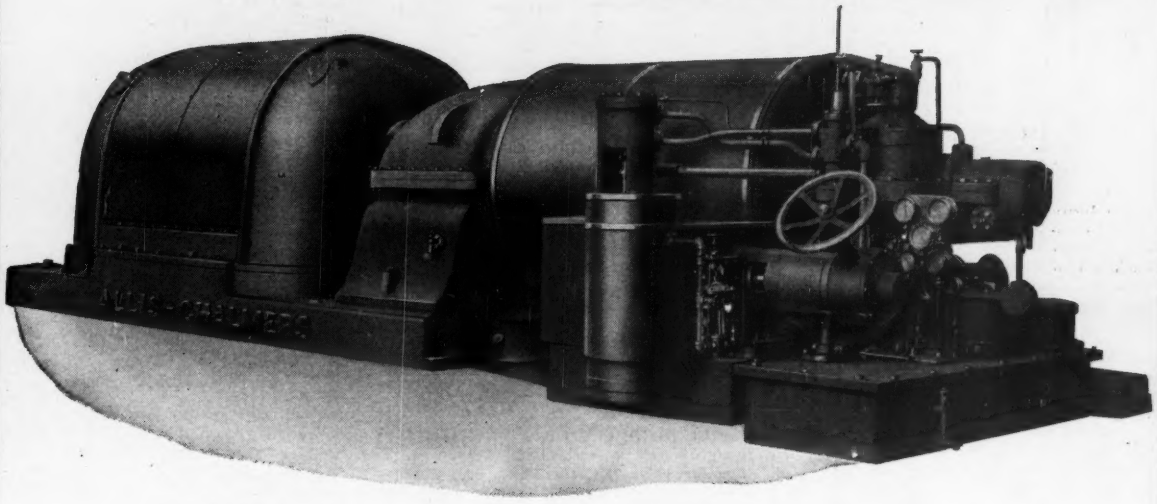
SOME INSTANCES OF

DEPENDABILITY

IN

ALLIS-CHALMERS STEAM TURBINES





Union Pacific Coal Co.—After fourteen years of service, inspection showed blading in practically perfect condition. All blading in this Turbine was the original blading as shipped with the unit.

Stark Electric R. R. Co.—Turbine No. 7 built in 1906 still in continuous daily operation.

The Langeley Mills—Six years of continuous Turbo-Generator service with practically no repair cost.

Illinois Steel Co.—Cylinder cover removed after six years' service shows blading unaffected by erosion and corrosion. Turbine operated at loads varying from full load to no load within two or three seconds.

The Ozark Smelting & Mining Co.—Negligible repair costs and maintained economy demonstrated by 7 years of continuous operation.

Operating records speak for themselves.

Before purchasing, ask any owner or operator of an Allis-Chalmers Turbine.

ALLIS-CHALMERS MANUFACTURING CO.
MILWAUKEE, WIS. U.S.A.

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